THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 56 Thursday, February 4, 1937 No. 1068

PUBLISHED WEEKLY

Subscription Terms : 15s. per annum.
Foreign and Colonial : 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address : "Zacatecas, Rand, London."
Telephone : Temple Bar 3951 (5 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen

The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT : 1935-36

H. Winterton, "Moorlands," Milngavie, Dumbartonshire.

LIST OF SECRETARIES—

General Secretary : T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office : 49, Wellington Street, London, W.C.2.

Birmingham, Coventry and West Midlands : A. A. Timmins, A.I.C., 21-23, St. Paul's Square, Birmingham.

East Midlands : B. Gale, "Parkdale," Boulton Lane, Alvaston, Derby.

Lancashire : J. E. Cooke, 1, Derbyshire Crescent, Stretford, Manchester.

London : H. W. Lockwood, Stewarts and Lloyds, Limited, Winchester House, Old Broad Street, London, E.C.2.

Middlesbrough : D. R. Kinnell, Chas. P. Kinnell & Company, Limited, Vulcan Ironworks, Thornaby-on-Tees.

Newcastle-upon-Tyne : W. Scott, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead-on-Tyne.

Scottish : J. Bell, 60, St. Enoch Square, Glasgow.

Sheffield : T. R. Walker, B.A., "The Priory," Oughtibridge, near Sheffield.

Wales and Monmouth : J. J. McClelland, 12, Clifton Place, Newport, Mon.

West Riding of Yorkshire : S. W. Wise, 110, Pullan Avenue, Ecclesshill, Bradford.

Bristol : A. Hares, Park Crescent, 648, Stapleton Road, Bristol.

Burnley : W. Haworth, 37, Westbourne Avenue, Burnley, Lancs.

East Anglian : J. L. Francis, 53, Cromer Road, Ipswich.

Falkirk : H. McNair, "Braewick," Larbert Road, Bonnybridge, Scotland.

Lincoln : E. R. Walter, M.Sc., The Technical College, Lincoln.

Preston : P. Leyland, 7, Ashley Terrace, Farington, Lancs.

The Institute of Vitreous Enamellers

President : Dr. J. W. Mellor, F.R.S., Sandon House, Regent Street, Stoke-on-Trent.

Chairman : W. H. Whittle, W. H. Whittle, Limited, Eccles, near Manchester.

Hon. Secretary : Miss E. Christine Elliot, 49, Wellington Street, Strand, London, W.C.2.

Foundry Trades' Equipment and Supplies Association

President : G. T. Lunt, "Briardene," Newbridge Avenue, Wolverhampton.

Secretary : K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association

President : W. E. Clement, Morfa Foundry, New Dock, Llanelly.

Secretary : J. D. D. Davis, 9, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION

The Registered Office and Laboratories of the B.C.I.R.A. are :—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone : Central 1885. *Telegrams : CIRA*
The B.C.I.R.A. Scottish Laboratories are :—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone : 332

Contents

	PAGE.
Vocational Education	111
The Field for High Quality Irons	111
London Foundrymen's Visit to Belgium	112
District Presidents : S.A. Branch, I.B.F.	112
Random Shots	112
Some Considerations of Cupola Operation	113
Annual Dinner : East Anglian Section, I.B.F. ...	115
Ingot Mould Castings	116
Who Will Control Copper?	117
Institute of Metals : Programme of Annual General Meeting	118
Dimensional Tolerances	118
Vitreous Enamelling Section—	
Metal Degreasing Prior to Vitreous Enamelling	119
Mill Room Practice	124
Short-Cycle Annealing	126
South African Foundry Developments	126
The Week's News in Brief	128
Trade Talk	128
New Companies	128
Company Reports	128
Obituary	128
Personal	128
Forthcoming Events	128
Raw Material Markets	130

Vocational Education

There is something very nebulous about the word "vocational," which only means "calling," and one individual will mentally define it as a preliminary to a craft apprenticeship or its modern counterpart, whereas a second will interpret it as a training to take an undefined position in any industry. Thus when we received for comment a pamphlet (price 6d.), prepared by the British Association for Commercial and Industrial Education, being a Report of an Inquiry into Vocational Education up to the age of sixteen, we hoped to find immediately what they had in mind, but no real differentiation of the two phases has been made, and thought is given only to the early stages of youths' careers. The view is expressed, and with this we are in absolute agreement, that part time education has much to commend it. The Association summarises its conclusions in the following terms :—(*a*) Workshop or office experience and school instruction should be complementary to one another, one giving the practical and the other the theoretical side of the complete training of the recruit; (*b*) workshop or office experience concurrently with attendance at school develop in the recruits certain valuable qualities, amongst which is the habit of hard work; (*c*) it is important that the recruit should enter business early in order that he may become thoroughly accustomed to its atmosphere and its conditions at a impressionable age. He is more willing to perform minor and unimportant tasks at 16 than he is at 18, if he has remained at school until the latter age; (*d*) entrance to employment at 16 results in there being fewer "misfits" ultimately, since it is easier to find a more suitable or more congenial occupation at this age than at, say, 18, when valuable time may have been spent in preparing for a particular occupation, and (*e*) in some industries the demand for highly trained young men is so small that it would not be worth while to organise full-time instruction for them locally.

The report has some sound, if stereotyped, remarks to make on such subjects as the "organisation of practical experience," "time off for the purpose of attendance at school"—strangely enough, however, there is no reference in this section to the nerve wrecking conditions of modern industrial life which forms the *raison d'être* for the factory legislation now being discussed in the House of Commons—"the Sandwich system" and "the secondary school." As to full time vocational courses, the committee's inquiry revealed that they are favoured by less than one-tenth of the employers and associations approached.

Finally, as this problem is an individual one, dealing with human beings and not machines, everything should be done (1) to provide a maximum of elasticity in industry and individual, (2) to introduce personal guidance from his parents, teachers, employer, manager or foreman and (3) to ensure that facilities for technical and *general* education are provided. We have italicised "general," because we often find that an untutored high-grade craftsman imagines that if he knew more about the theory of his craft, he could command a foreman's position, whereas in reality he needs additional training in the very elementary things he should have learnt in standards one to six.

The Field for High Quality Irons

The first step in the production of high quality cast irons is to know and to be able to control the composition of the metal. With such control it becomes possible to cast straight irons of strong character with that all-pearlitic structure, possibly with a little free carbide, which gives the maximum mechanical properties associated with a straight cast iron. Further improvement is possible by the use of alloy additions. These must, of course, be used with full knowledge of their various effects. Beyond this, the cast material can be still further strengthened by judicious heat-treatment. By this is not implied the simple annealing required for the removal of internal stress, or the improvement of machinability or magnetic properties, but the heating, quenching and tempering so often necessary in steel practice. The process of adding a ladle graphitiser or inoculent to molten metal which then casts grey instead of white is the next step, and the highest figures obtained to-day from cast irons are secured in this way. They are capable of still further improvement by alloy additions and by the process of heat-treatment. The final stage in this process of development consists in casting a low carbon white iron and submitting this to a heat-treatment which will enable it to be processed in the machine shop. The graphite of such materials consists frequently of temper carbon, and tensile strengths of the order of 60 tons per sq. in. have been and can be obtained, which is far above the 10 tons per sq. in. that so many engineers still think represents the quality of cast iron. These approach what may almost be described as a malleable iron, produced as they are from a white iron, heat-treated and having a measure of elongation in the finished state. They require a considerable amount of knowledge and experience to make, but there is little doubt that enterprise shown in their manufacture will have its reward.

London Foundrymen's Visit to Belgium

As was announced in our issue of January 7, the London Branch of the Institute of British Foundrymen has arranged a visit to Belgian foundries, which will take place from March 17 to 21.

The following is the full programme which has been arranged:—

Wednesday, March 17.

8.30 p.m.—Leave Liverpool Street Station, London.

9.57 p.m.—Embark at the Parkeston Quay, Harwich.

Thursday, March 18.

Breakfast on steamer. 8 a.m.—Arrive Antwerp.

Visit works of Société Belge Griffin at Merxem (near Antwerp). This company manufactures chilled rolls, railway wheels and other chilled castings. Lunch in Brussels.

Visit to Les Fonderies Nestor Martin at Berchem-St.-Agathe, near Brussels, where stoves, ranges, etc., are manufactured and enamelling is carried out. Les Fonderies Nestor Martin reserve the right of admission to their works. Train to Liège, arriving at the Hotel de Suède for dinner.

Friday, March 19.

8 a.m.—Leave Liège to visit the foundries of John Cockerill & Co., Seraing. Lunch at Seraing.

Visit foundries of S. A. Espérance-Longdoz. Both these foundries manufacture all kinds of engineering grey iron castings, steel and non-ferrous alloys. Return to Liège for dinner at Hotel de Suède.

Saturday, March 20.

Conducted tour of Liège and a visit to one of the famous forts which defended the city in August, 1914. Lunch at Hotel de Suède. 4.2 p.m.—Leave Liège for Antwerp. 6.50 p.m.—Embark Antwerp. Dinner on steamer.

Sunday, March 21.

6.15 a.m.—Arrive Parkeston Quay, Harwich. Entrain for London. 8.38 a.m.—Arrive Liverpool Street; breakfast on the train.

The inclusive fare per person will be £8, provided that the party numbers not less than 20, but this amount does include gratuities to railway and steamer porters. Evening dress will not be required, but passports are required.

Members intending to take part in the tour should communicate with Mr. H. W. Lockwood, Winchester House, Old Broad Street, London, E.C.2.

Davy Bros. and United Engineering Company

A fusion of interests has been arranged between Davy Bros., Limited, of Sheffield, and the United Engineering & Foundry Company, of Pittsburgh, U.S.A. Davy Bros. have obtained the sole right to manufacture and sell all the products of the American company in the British Empire with the exception of Canada, while the Pittsburgh company will have the right to manufacture and sell in North America Davy Bros.' speciality products. Mr. K. C. Gardner, Vice-President of the United Engineering & Foundry Company, has joined the board of Davy Bros., whose name will be changed to Davy & United Engineering Company, Limited. The company will continue to manufacture continuous rolling mills in co-operation with the Morgan Construction Company, of Worcester, Mass., U.S.A., in addition to their own wide range of specialities, which include forging and extrusion presses. Davy Bros., Limited, recently acquired the old-established business of the British Chilled Roll & Engineering Company, Limited, of Middlesbrough, and it is intended to extend the works of this company. The large extensions of Davy Bros.' works at Sheffield are approaching completion.

District Presidents

SOUTH AFRICAN BRANCH OF THE INSTITUTE OF BRITISH FOUNDRYMEN

Mr. T. Nimmo Dewar, the first President of the newly formed South African Branch of the Institute of British Foundrymen, was born in Scotland in 1886 and went to South Africa early in 1907.

Most of his technical education was acquired at the Glasgow University and the Glasgow Royal Technical College during 1902-1907. Civil and mining engineering was his choice for a profession, and after five years in the collieries in Scotland, he continued on the Natal coalfields until 1912. Metal mining next claimed his attention, and he was employed at the

MR. T. NIMMO DEWAR.

Witwatersrand Gold Mines until 1919, when he entered the Union Mines Department as Assistant Inspector of Mines, a post he held until 1923.

During the next ten years he was employed by the Vereeniging Estates Collieries Section in the Lewis & Marks Group as mine manager, in the first instance, and later as consulting engineer to the six collieries.

His association with the iron and steel industry dates from 1926, when he became consulting engineer to the Union Steel Corporation, and four years later joined the board as a director. In 1933 he was appointed managing director of the company. In addition to this post he holds certain other directorates with allied companies, which are of increasing importance due to the industrial development of Vereeniging.

Mr. Dewar is President of the Associated Scientific and Technical Societies of South Africa, a body which controls the technical activities of a group of eight societies with members scattered throughout South Africa and abroad.

THE SCOTTISH AIRCRAFT & ENGINEERING COMPANY, LIMITED, has completed negotiations with Lord Nuffield for the purchase of his Wolseley aero-engine business, including the whole of the plant and machinery of Wolseley Aero Engines at Birmingham. Included in the arrangement is an understanding that the whole of the business—including the plant and machinery—shall be transferred to a distressed area. The purchasers announce that they have decided to build a modern works on the Clyde.

Random Shots

"Marksman" has a sad story to tell as a sequel to last week's revellings, and let it be a lesson to over-enthusiastic foundrymen who spend their evenings at meetings and their nights entertaining their fellow-men in the wife's drawing room afterwards . . . his wife was determined to cure him of this pernicious habit. Next morning for breakfast she treated him to chilled rolls, toast with a high carbon content, and a tapping of coffee scarcely freed from its slag. Placing this before him she gaily greeted him with "Cheerio, darling, I must hurry to fettle my kitchen, then I've got a meeting of the Amalgamated Society of Wire Drawers, and shan't be in for dinner. Chin chin!"

* * *

It seems that the Worshipful Master of the Guild of Founders is a caterer in a big way. Do our pig-iron merchants know of this probable market for surplus stocks of pigs? It is sad to reflect that few founders, the founders of this Ancient Guild of Founders, are no longer to be found amongst its exclusive membership.

* * *

Marksman can explain to would-be contributors to the F.T.J. why their articles are being rejected just now. The Editor is using a voting pencil, and it automatically registers a thick black cross. Young aspirants are advised to enclose a pencil with their efforts. The pencil-snavelling instinct must be very well developed in Editors when they can successfully extract one from a voting booth!

* * *

One cannot help but admire the grit of the school-boy broadcasting the other night who wishes to study special steels when he leaves school. Or is it just another case of "where ignorance is bliss," etc.? Somebody ought to take him on one side and whisper in his ear "sash-weights for you, me lad, its easier."

* * *

The stainless steel signs on Sheffield station are an example that might be followed by other manufacturing towns with some success. Manchester porters might work in shirt sleeves. Leicester might have lady-attendants in dainty silk stockings (incidentally, the railway bun might become more popular). Heathfield might have a fleet of Fords waiting for the free use of passengers. Bristol might offer a cigarette in exchange for the railway ticket—and so it might be developed.

* * *

The world seems to be noticing at last the existence of the soya-bean, and "Marksman" wonders if those core-oil manufacturers who are discovering its useful properties know to what extent it is used in Japan. There it is a sort of magic bean which provides food and drink, is used as a substitute for rubber, petroleum, shellac, varnish, and experiments are being carried out to discover its usefulness in the manufacture of artificial silk. It is grown in Manchukuo, but Mr. Ford has been cultivating it with success in Essex for the past few years.

"MARKSMAN."

SPEAKING AT THE ANNUAL MEETING of Barclays Bank Limited, on January 21, Mr. Edwin Fisher (chairman) expressed the hope that the prosperity which existed in most sections of the home market, and the difficulties of conducting foreign trade, would not result in the development of domestic business to the neglect of overseas connections. Such a policy, if pursued, would be short-sighted and unsound, for the time might come when domestic business would prove less attractive than at present, and foreign connections, once lost, were not easily recovered.

Some Considerations of Cupola Operation*

By H. H. SHEPHERD

Introduction

The initiation of the cupola furnace is usually attributed to that well-known eighteenth century English foundryman, John Wilkinson, but it would be more correct to state that this furnace was gradually evolved from the blast furnace and its modifications. It may be correct to state also that his patented "low erection, not exceeding 10 feet high" furnace was the forerunner of the cupola. As to the method of operation such as it is known to-day, the first recorded instance of alternate charging of pig-iron, scrap and coke is that contained in a patent granted to a John White in 1824.

The past 15 to 20 years have seen several other methods of melting iron for the foundry introduced and, in some cases, these new methods have become firmly established. One could give numerous instances where one or other of these newer melting mediums have displaced the cupola; nevertheless, the prophets of a few years ago who said that the introduction of a particular method of melting would result in the extinction of the cupola have been proved wrong. The application of these more modern methods, like the application of mechanisation to the foundry, can be overdone, and it can prove to be entirely wrong in some cases.

The author would hasten to add that he does not possess any views which may be termed old-fashioned or biased, but the facts are that there is still much in favour of cupola melting as an efficient and economical melting method under many conditions. High-quality castings of all sizes, shapes and weights can be produced from many widely differing types of mixtures ranging from ordinary white irons—including those requiring subsequent treatment to render the castings made from them into malleable cast iron—through countless varieties of ordinary grey cast irons to alloy cast irons.

* A Paper read before the East Midlands Section of the Institute of British Foundrymen, Mr. Tibbenham presiding. The author is chief metallurgist, Cranes, Limited, Ipswich.

Inherent Advantages

It is well worth while to note some of the advantages of cupola melting:—

(1) The cupola is the quickest method of melting;

(2) It is the cheapest method of melting when considered from the practice of melting, alone;

(3) With the exception of the electric furnace, the cupola has a higher thermal efficiency than any other furnace. This thermal efficiency ranges from 35 to 45 per cent.;

(4) Properly controlled cupola practice will give a continuous supply of hot and what is of perhaps greater importance—exceptionally fluid iron; and

(5) There is another advantage, which is that cupola melting is eminently suitable for foundries requiring a continuity of metal supply over long periods of time.

The quality of cupola metal can be very much enhanced if the management is prepared to give as much care to control as is given to other types of melting furnaces. Fundamentally, the cupola has not altered in its general design and method of operating over the past 100 years or more. There have been many patents relating to design and practice almost since its inception, but most of them are obsolescent, and one can set down the chief modifications as being again brought about more by evolution than by sudden changes. The height, for instance, has been gradually increased and the modern counterpart of John Wilkinson's "low erection furnace not exceeding 10 feet high," is a structure which may vary in total height from 22 to 40 feet.

Construction

The most important dimension in respect of the furnace height is the distance between the top of the first row of tuyeres and the charging door sill. This is known as the effective height, since the shorter it is the less the efficiency due to heat losses and loss by incomplete combustion. The shorter this height the greater the tendency for flames or combustible gases to be present at the charging door, yet lack of flame at the charging door does not necessarily indicate efficient practice, it all depends upon the amount of CO gas escaping, each unit of which represents a loss of two-thirds of the available heat units. From this it follows that the only sure means of determining how efficiently a cupola is operating in respect of combustion is to analyse the top gases. For ordinary practice the CO content may range from 6 to 10 per cent. or more, with properly controlled practice it can be brought down to 3 or 4 per cent. and, in certain practice, may be less than 2 per cent.

It will be appreciated that as the effective height of the cupola increases so does the resistance to the blast increase, therefore, there is a limit to this effective height. In cupola design it is usual to calculate the effective height on the basis of ratios to the diameter of the furnace at the melting zone; these will range from 4.1 for small cupolas, to as much as 6.1 or more for larger sizes. The height from the base plate to the charge door of moderate-sized cupola should not be less than five times the melting zone diameter if one is to obtain efficient practice.

Diameter of Shell

It follows, as a matter of course, that the size of cupola one uses is almost entirely governed by the output required. In actual fact, the larger the diameter the better the results, other things being equal, and with the proviso that all the metal melted can be handled without recourse to the practice of putting the blast on and off, a procedure which is fatal to good cupola operation.

It is generally advisable to instal a cupola which will permit melting of more iron per hour than the amount actually required, immediate requirements being controlled by increasing the thickness of the lining. Double the initial melting requirements is a safe figure to work to in selecting a suitably sized furnace. It should not be more than two and a half times the immediate capacity required per hour, otherwise the lining will be so thick that a great deal of extra coke will be necessary in the bed and first few charges to heat this lining, resulting in abnormally high carbon and possibly high sulphur metal. Moreover, such practice is not economically sound, and may react very definitely against securing good castings.

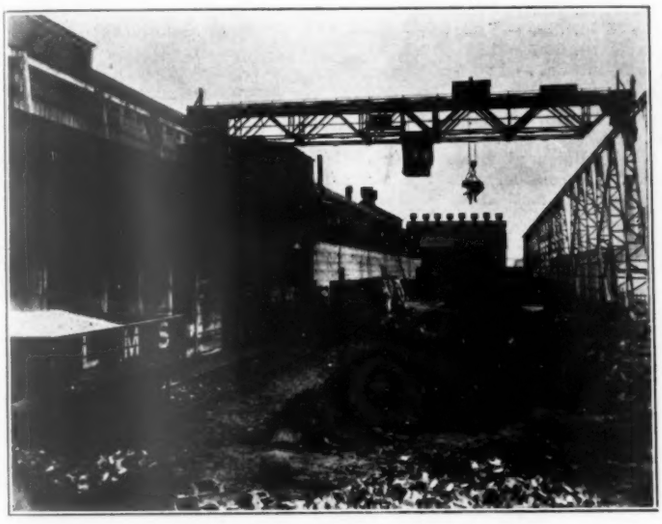


FIG. 1.—METHOD OF HANDLING RAW MATERIALS AT THE AUTHOR'S FOUNDRY.

FIG. 2.—SHOWS THE SLOPING BINS AND SPECIAL CONTAINERS TO HANDLE RAW MATERIALS.

Tuyeres

As to the position of the tuyeres, the height of the first—or maybe the only—row from the base plate will be largely governed by the amount of iron (if any) it is desired to store in the well. Two to two and a half feet from the base plate represents average practice when a fair storage is required, but in receiver or continuous melting practice this height is usually much less and may only be a few inches. Considering the effects of tuyere positions alone, low tuyeres increase the effective height of the cupola and, of course, save bed coke. Furthermore, when it is realised that the coke bed below the tuyeres has no effect upon the speed of melting, and one can say that this coke has no beneficial effect upon the temperature of the iron, it may have detrimental effects; then for best results the tuyeres should be as low as is consistent with the amount of metal it is required to hold in the well before tapping. The height of the tuyeres will determine the height of the bed.

Most of the statements just made refer to a single row tuyere condition, whereas modern practice employs two or more rows of tuyeres. There have been many modifications in the design, number and positions of tuyeres. Two rows, three rows and spirals of tuyeres, the last system being first used about 1850-60, have all been employed to a greater or lesser extent, but with the exception of one or two types of cupolas, these varieties have died out, and it is found that the ordinary two row tuyere design predominates.

Summing up this question of "one or two rows of tuyeres?" the author would express the opinion that two rows of properly designed and positioned tuyeres will result in more rapid melting and hotter iron than is usually the case if one row only is used.

The most suitable shape for tuyeres is a matter which involves many opinions, but perhaps the slightly flared tuyere of not too large dimensions would meet with general acceptance. By "not too large dimensions" is meant that it is far better to employ a number of tuyeres of such size to have the desired total area at the outlets than to use only two or three; this is especially the case with flared tuyeres.

It is well known that the total cross sectional area of the tuyeres should bear some definite relationship to the area of the furnace at the melting zone. Many years ago Cook recommended the following, based on the type of castings produced:—

For soft castings, tuyere area = $\frac{1}{5}$ of melting zone area.
For general castings, tuyere area = $\frac{1}{6}$ of melting zone area.
For cylinder castings, tuyere area = $\frac{1}{7\frac{1}{2}}$ of melting zone area.

An American authority, Y. A. Dyer, also some years ago, published the following recommendations for the ratio of tuyere area to cupola area:—

For cupolas from 24 in. to 42 in. dia. = 1:5.
For cupolas from 44 in. to 62 in. dia. = 1:6.
For cupolas from 64 in. to 82 in. dia. = 1:7.
For cupolas from 84 in. to 90 in. dia. = 1:8 to 1:8.3.

FIG. 3.—SHOWING DROP BOTTOM TYPE BUCKET USED FOR MECHANICALLY CHARGING A CUPOLA.

Undoubtedly, the most successful practice which has incorporated more than one or two rows of tuyeres is that of the Balanced Blast system. Space will not permit the consideration to any extent of this design and method of cupola operation, which was devised by Fletcher, and which is patented by the B.C.I.R.A. E. Wharton, W. Y. Buchanan and the author of this Paper have dealt pretty fully with the Balanced Blast cupola system, and those who are further interested are referred to these Papers. [1] [2] [3] [4]

The rapid and continued success of Fletcher's system is strikingly illustrated by the fact that within the course of about six years something like 140 Balanced Blast cupolas have been installed, and the total hourly capacity is over 1,000 tons. Further, their installation has been widespread, for besides many which are operating in this country, there are also many in use or in course of installation in Australia, India, America, Denmark, China, Czecho-Slovakia, Germany and France, etc. Surely, a remarkable achievement in a comparatively short space of time.

It can be stated without fear of contradiction that this success is due to the fact that Fletcher was the first to realise that to secure and maintain a properly balanced atmosphere, would necessitate a specially designed cupola, particularly relating to the tuyeres, and that all these would require to be adjustable in order to obtain the correct balance of air between the main lower tuyeres and the auxiliary upper tuyeres. Further, the attainment of a correctly balanced atmosphere was worked out by Fletcher on different lines from those previously adopted; in other words, the principle adopted by him, as a result of investigation and experience of many types of melting and smelting furnaces, was that the air supply to the lower part of the coke bed should be restricted so as to limit the amount of free air or oxygen in this zone to the lowest practical limit and, at the same time, maintain the maximum amount of carbon monoxide in these gases.

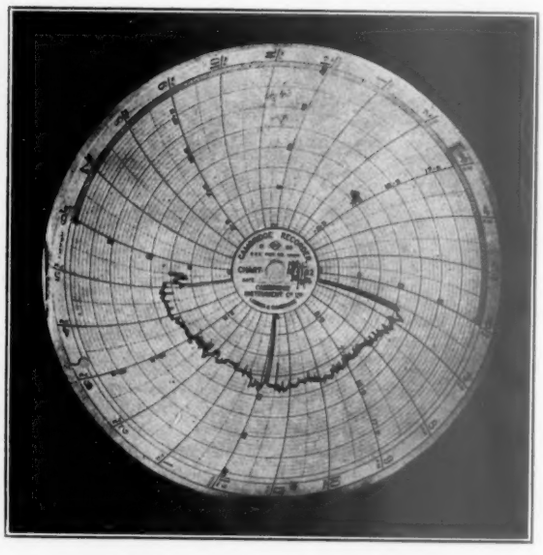
The carbon monoxide is later burnt to carbon dioxide by the auxiliary tuyeres. The practical result is that, rapidly melted, high temperature and fluid iron freer from oxidation, is obtained under economical conditions, and invariably the Balanced Blast system shows considerable savings in coke.

Charging

Mechanical handling is rapidly taking the place of manual labour and modern foundry stock-yards are usually equipped with overhead travelling cranes.

Figs. 1 and 2 illustrate the method of raw materials handling at the foundries with which the author is associated. The materials are loaded into sloping bins from which they can be raked into specially designed containers which pass over weighbridges in order that the appropriate amount of each of the constituents of the cupola charges can be weighed to within reasonable limits.

Mechanical charging of cupolas is becoming more and more popular and is, in fact, almost a necessity for cupolas operating large melts over long periods. There are, however, few mechanical chargers which do the job really efficiently, the most satisfactory type, so far as the author is concerned, is that employing the



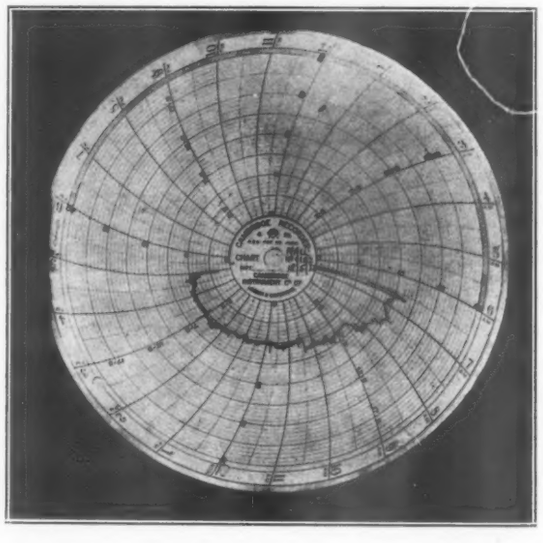


FIG. 4 (LEFT) AND FIG. 5 (RIGHT) SHOW BLAST PRESSURE CHARTS OF A BALANCED BLAST CUPOLA.

"drop bottom" bucket principle. The type of bucket and method of operation are illustrated by Fig. 3.

If the installing of a cupola plant and mechanical charger is contemplated, then a fair sized cupola platform is recommended as an investment well worth while. For mechanical charging the author does not advise mixing the coke with the metal charge in the buckets, but recommends that a supply of coke and limestone be kept on the cupola platform, and that these are weighed and charged into the furnace separately, preferably by the man handling the bucket hoist if this be the system employed.

So far as hand charging is concerned, too much stress cannot be laid on the fact that to charge a cupola correctly in order to obtain uniformity of melting does require some care and thought. To put any sort of labourer to "throw in" the charge is a great mistake. It is well worth while making sure that charging is carried out correctly, and even with mechanical means some considered attention must be given if the best results are to be obtained.

Blowing Units

The centrifugal fan has come to be accepted as an efficient means of supplying the air blast. It is cheaper and less costly to maintain than the positive blower of the Roots type, and since the electric current consumed is proportional to the volume of air used, the power costs are also less. The delivery of air is more automatically and simply controlled with the fan blower, for, since the quantity of air delivered varies with the resistance met, control of air volume can easily be obtained by operation of a blast gate fitted directly in the main blast pipe. For these reasons a variable speed motor is not necessary.

Fan blowers are much more sensitive to furnace variations, such as obstructions, slagging of tuyeres, etc., than are positive blowers. Another point of interest with regard to the latter is that usually a more uniform volume of blast results than from a fan, especially when the equipment is new or kept in first-class condition.

In U.S.A. there are many cupolas receiving their air supply from Roots type blowing plants, This is probably because of the much larger size of cupola than is customary in this country, and, obviously, with such furnaces the resistance offered by the charges is very considerable. However, even in these cases the fan is replacing the positive blower.

Considering fans and blowers purely from a point of view of efficiency of cupola control, the author has no definite opinion or recommendation to offer. He is inclined towards favouring the positive blower, and some of the advantages of this method of supplying air, which have been referred to, namely, the greater tendency to a more uniform air volume and less susceptibility to furnace conditions, have influenced the author in this direction. During a recent visit to many German foundries the author was very interested by the fact that the positive blower was being used exclusively.

Constant Volume Essential

In modern cupola practice it is recognised that pressure is only of secondary importance compared to the *volume* of air entering the furnace. The blast should, therefore, be regulated to keep a constant volume; with a positive blower regulation this is controlled by varying the speed of the driving motor. It is advisable with fan blowers to regulate the volume by a blast gate in the main which is now the recognised practice. Fan blowers should be so equipped that they can be driven at such a speed that sufficient volume is available at the highest pressure likely to be encountered. Good practice should aim at controlling the volume of air for small and medium sized furnaces, within plus or minus 5 to 7½ per cent. of the air required per minute, and within 10 per cent. for large cupolas.

Whilst volume is of first importance, pressure conditions and control should also be taken into account. As is well known, the pressure of the blast required usually increases with increase in diameter. The tendency to blow at high pressures was associated with the time when positive blowers were more popular than they are now.

The positive blower, as its name implies, a positive pressure, but as previously stated, in the case of the fan the indicated pressure depends to some extent on the resistance offered by the charges in the furnace and any obstructions at the tuyeres. For this reason, knowledge of the volume of air delivered to the cupola per unit time becomes of increasing importance. Reliable instruments can now be purchased to measure and record blast volume and pressure.

If founders are seeking correct air control in conjunction with the proper measuring instruments the following warning is given. Make sure that the cupola is reasonably airtight at the tuyeres, connections, etc., and that welded and other types of joints in the delivery pipes and air belts have not cracked or warped, otherwise the figures as to air supply will be erroneous and consequently very misleading.

The author's practice is to blow with as low a pressure as is consistent with obtaining the required air volume and melting rate, other things being equal. For a 27-in. melting zone diameter cupola 7.5 ozs. was the average pressure used, whilst it was found that in the case of Balanced-Blast cupola practice the pressure could be as low as 5 to 6 ozs. and still become very hot and fluid iron. Figs. 4 and 5 show blast pressure charts of a Balanced Blast cupola which was operated under these conditions.

Actual Requirements of Air

To calculate the amount of air required a practical figure of 140 cub. ft. per pound of coke can be used when the coke contains 92 per cent. carbon. Using this figure and a metal to coke ratio of 10:1, it is found that 224 lbs. of coke and 31,350 cub. ft. of air will be required per ton of metal. Multiplying this figure by the hourly melting rate of the cupola gives the amount of air required per hour. H. V. Crawford has clearly shown that the quantity of air required may vary from approximately 30,000 to 20,000 cu. ft. per ton of iron depending upon variations in atmospheric conditions, and that for correct practice the air should be measured by weight and not by volume, in order that the amount of oxygen shall be constant. Space prevents detailed consideration of this interesting and important phase of cupola practice, and this section of the subject will be concluded by strongly recommending the use of a somewhat lower volume of air—about 5 per cent.—than the calculated requirement. It is, in any case, advisable to employ the minimum rather than the maximum quantity.

(To be concluded.)

REFERENCES.

1 "Cupola Control—Its Progress, Practice and Value in the Foundry," FOUNDRY TRADE JOURNAL, February 16, 1933.
2 "The Balanced Blast Cupola," FOUNDRY TRADE JOURNAL, January 16, 1936.
3 "Some Experiences with the Balanced Blast Cupola," FOUNDRY TRADE JOURNAL, December 29, 1932, and January 5 and 12, 1933.
4 "Modern Cupola Practice," FOUNDRY TRADE JOURNAL, February 8, 1934.

(Concluded from next column.)

could break away from its parents and become a Branch, and he paid warm tributes to Mr. J. L. Francis.

MR. H. H. SHEPHERD, responding, said he was formerly a member of the Institute's first Branch at Birmingham, and had grateful recollections of the late Mr. R. Buchanan, from whom he had gained much of his early knowledge of foundry practice.

The meeting was entertained by Mr. H. A. Fox (a member of the London Branch) and by the Regina Concert Party.

Annual Dinner of the East Anglian Section

Mr. L. Tibbenham (President of the East Anglian Section of the Institute of British Foundrymen) presided at the first annual dinner of the Section, held at the Crown and Anchor Hotel, Ipswich, on January 21. Those present included Mr. H. Winterton (President of the Institute), Mr. V. Delport and Mr. H. W. Lockwood (President and hon. secretary of the London Branch respectively), Col. C. Portway and Mr. H. H. Shepherd (Senior and Junior Vice-Presidents of the East Anglian Section respectively), Mr. C. H. Kain (Past-President of the London Branch), Mr. G. Detlefsen, Mr. H. A. Hartley and Mr. J. L. Francis (hon. secretary of the East Anglian Section).

The Toasts

The loyal toast having been honoured, MR. L. TIBBENHAM (President of the Section) proposed the toast of the Institute, coupled with the President, Mr. H. Winterton. In the course of his speech he outlined the history of the Institute and of Mr. Winterton's membership of it since 1905 up to the time of his election as President last year.

The PRESIDENT, in his response, described how he had himself witnessed the growth of the Institute, and congratulated the East Anglian Section. Speaking of the Scottish Branch, he said how much in earnest they were in their endeavour to educate the younger members of the foundry trade. He foresaw more recognition for foundrymen in the future than in the past. Castings, he said, were better to-day than ever before, and the efforts of the Institute had contributed to this. Mr. Winterton also said that the membership of the Institute was now over 2,000. He would like to see more conjoint meetings, and said that the recent one with the Iron and Steel Institute was all to the good.

The toast of the visitors was proposed by MR. J. L. FRANCIS, who read letters of apology for absence from Mr. W. B. Lake (hon. treasurer of the Institute), Mr. T. Makemson (hon. secretary of the Institute), and Mr. A. J. Richman. He thanked all those present for their support of the Section's first annual dinner, especially those who had travelled long distances to be present. It was this active support that encourages and ensures continued success and growth of the Section. Arrangements such as the use of a room at Ranelagh Works to which to hold Council Meetings also was greatly appreciated. He pointed out that although the Section was holding its first annual dinner, it was only just 7 months old, but it already had 44 members. MR. B. B. KENT replied to the toast on behalf of the visitors.

MR. G. HALL proposed the toast of the London Branch, to which Mr. V. Delport (London Branch-President) replied. Mr. Delport explained how much of the credit for the success of the East Anglian Section was due to the organising ability of Mr. L. Tibbenham, its President, and Mr. H. Lockwood, together with the hard work of Mr. J. L. Francis. He hoped the Section would eventually achieve the status of a Branch, but meanwhile the London Branch would remain the parent Branch, and he hoped the Section members would attend as many of the London Branch functions as possible.

MR. H. LOCKWOOD, in proposing the toast of the East Anglian Section, said that the true story of the formation of the Section was that Mr. L. Tibbenham was its father and the London Branch Council its mother. Mr. H. H. Shepherd had nursed the child which was just 7 months old. Mr. Lockwood said he also was looking forward to the time when the child

(Concluded in previous column.)

Ingot Mould Castings

At a recent meeting of the Lancashire Branch of the Institute of British Foundrymen, Mr. R. Ballantine read a Paper on "Developments in the Production of Ingot Mould Castings." This Paper was published in our issues of January 7 and January 14, and the discussion is printed below.

Vote of Thanks

MR. H. V. GRUNDY, in proposing that a very hearty vote of thanks be accorded to the author for his interesting Paper, said that ingot moulds were required to be absolutely perfect. Probably a thin shell scab, $\frac{1}{8}$ in thick, a little depression on the core, or a little projection on the mould, would be quite sufficient to scrap the casting. In addition to this some buyers imposed very fine compositional tolerances, frequently of the order of 0.03 per cent. S and 0.02 per cent. P as the maximum. Straight pig-iron was necessary, and steps had to be taken to counteract the sulphur pick-up. The lecture was an unusual one for the Lancashire Branch, and it had been listened to with very great interest.

Phosphide and Flaking

MR. E. LONGDEN, seconding the vote of thanks, remarked that, as had been anticipated, Mr. Ballantine had prepared an extremely practical Paper dealing with the application of moulding to ingot mould production and practical metallurgy. Although he, the speaker, had made ingot moulds up to 50 tons, he had nevertheless learned a great deal from the Paper, particularly in regard to cores and the unusual methods of constructing them in order to avoid many imperfections which occurred on ingot mould castings.

It was very interesting to think of some of the attempts to describe why ingot mould castings flaked and scabbed. One investigator who examined the flakes or scab metal found, on analysis, a high percentage of phosphide, and declared that the phosphide had influenced the scabbing of the cores, which was nonsense. The practice should be to prevent gases passing easily off the surface of the cores at the corners. By venting the corners from the outside and making an easy passage for the gases, the cores would not scab when pouring the casting.

Such points should be impressed upon the minds of all foundrymen. He had tried to prevent moulders polishing the faces of moulds before they put on the blacking, as a far better casting could then be obtained. A wide range in the analyses used had been presented. He was not alarmed about sulphur content if it was below 0.12 per cent., but certainly phosphorus should be kept at the lowest point.

The ideal sought was a metal which was really uniformly open-grained. Reference had been made to feeding, and Mr. Ballantine had explained the reason why he did not resort to feeding ingot moulds. The great amount of carbon precipitation counteracted the metal shrinkage. One could employ hematite iron, and it would illustrate very forcibly the compensating effect of carbon precipitation on liquid shrinkage and the feeding of castings. If a mould of any description was produced to his instructions, he would guarantee to produce castings without the ordinary liquid shrinkage cavities when made in grey hematite irons without feeding.

The vote of thanks was carried unanimously by acclamation.

Low Scrap Losses

MR. R. BALLANTINE, responding, said that as far as he was concerned analysis did not really worry him very much, simply because he had to consider the salvage value of the ingot moulds back to the steelworks. They purchased the hematite to a definite analysis, but they never got the broken ingot moulds back to use in the cupola. What he was concerned about was the manufacture of the core—to allow for the natural contraction of the casting. The firm with which he was associated made something well over 22,000 tons of ingot moulds last year, and they had only 3 castings scrapped in the foundry. Therefore, he thought they were very successful in the process they were using.

Sheffield Practice

MR. J. ROXBURGH (President of the Sheffield Branch) had very great pleasure in conveying greetings from the Sheffield Branch to the Manchester members. He had had the pleasure of visiting Mr. Ballantine's foundry, and could support everything which that gentleman had said. Mr. Ballantine was, however, definitely in an advantageous position. He was making his ingot moulds for one particular steelworks, and was doing about 600 or 700 tons per week. Therefore, it was possible for him to specialise in the manufacture of ingot moulds.

In Sheffield they were particularly interested in the manufacture of ingot moulds, but they worked an entirely different basis. Some of the steel firms had their own foundries; but, in the majority of cases, iron-founders were supplying the ingot moulds to the steelworks, which was quite a different matter. The only way in which they could tell whether the ingot moulds were satisfactory or otherwise was by the number of "lives" that were obtained, and yet they were to a great extent, as Mr. Ballantine had said, dependent upon the steelmaker. A great deal of harm could be done to the ingot mould in the steelworks. There had been instances, as Mr. Ballantine was aware, of moulds of similar capacity which had done well at one works and badly at another. When the matter was investigated from the foundry point of view it was discovered that they had been manufactured in an identical way. Therefore, it was felt at times that if the steelmaker paid more attention in a scientific way to the treatment of the moulds, better results would be obtained.

The sand was of vital importance in the manufacture of ingot moulds. Ingot moulds were manufactured in different parts of the country, and therefore it was necessary to explore the possibilities of the local sands. Mr. Ballantine had the advantage of the Scottish rotten rock sand. In Sheffield there were available for small moulds the Worksop red or sands of the red variety. Therefore, they endeavoured to get the best results out of the local sands, which was rather an important point in the case of the small moulds. It would appear that the sand Mr. Ballantine used was a coarse-grained sand, uniform in texture, and very permeable, and he had the advantage of a continuous sand preparing plant. Therefore, he could get rid of all his dust and silt, and control his sand in a very scientific way.

Sand Mixtures

In regard to his, the speaker's, particular foundry the output of ingot moulds would probably amount to 25 per cent. of the total output. Therefore, they were really jobbing founders. As a contrast to Mr. Ballantine's practice their cores for the small moulds were made as weak as possible. The mixture would be, approximately, a barrowful of black, and six shovelfuls of red sand. To that mixture they added a riddle-full of sawdust, which was passed through a one-sixteenth mesh sieve. It was not milled at all, but was simply mixed with a shovel. Thus, he regarded it as a particularly weak sand.

With regard to core barrels, they actually cast a small diameter core barrel on to the bottom core plate and round the core barrel they wound a straw rope. When they were ramming the core up they inserted four tubes opposite each corner, which were extracted, and then, contrary to Mr. Ballantine's practice again, they pricked the corners so as to make sure they were vented.

The procedure with regard to the mixing of the blacking was similar to Mr. Ballantine's method. In the case of small moulds they brushed the cores over with a plumbago wash, using a camel-hair brush. The inspection to which the moulds were subjected in Sheffield was particularly rigid. The moulds had to be very smooth inside and free from any defect. His own particular firm could ram with sand ingot moulds up to 12 or 15 tons. That was as far as they had gone with this practice, because, on the one hand, they could not afford to make a full pattern when it was a one-off job or even a two- or three-off job. The result was that in the case of the bigger moulds they had to make a skeleton pattern. This meant that above that weight they had to rely upon loam moulding.

Loam for Ingot Mould Making

MR. ROXBURGH said he had made ingot moulds up to 120 tons in weight in loam, but in his own particular foundry, at present, they could only manufacture castings up to 60 tons in weight. The manufacture of ingot moulds under those conditions, using loam moulding, was quite a different matter. In that case, too, they vented the corners, and counteracted the contraction stresses by building grids with dabbers into the cores and packing the bricks to the dabbers. They also made use of clamp bricks, and loam bricks to take care of the contraction stresses. Spaces were left at the corners, which were rammed with core sand, and pricking through into the centre with a vent wire was carried out.

Mr. Ballantine had mentioned the number of down-gates that he used, he also cut his in-gates, but he did not state the exact position of those in-gates, which was definitely a very important point. In Sheffield the practice was different from that adopted by Mr. Ballantine. They endeavoured to impart a spin to the metal, and the in-gates were run tangentially in the same direction. In Mr. Ballantine's foundry the in-gates were so placed that the metal was running in opposite directions.

The level of the in-gates was very important, for instance, if he had a 25-ton ingot mould to make he would have a down-gate on the one side with two in-gates, one in-gate would be placed about 1 in. from the bottom and the other about 7 in. above halfway; the down-gate from the opposite runner would enter about halfway up, just under the top in-gate of the other runner. It was contended that when the metal was spinning as it was rising, it was tending to lag when it got to the level of the top in-gate, and this latter in-gate helped to speed up the metal.

With regard to the feeding of the casting, he did not quite agree with Mr. Ballantine. If the ingot mould had to be machined on the top without any feeding head, he thought that defects would be shown. In Sheffield they laid particular emphasis on the fact that they must have level surfaces; they specifically precluded any flash on their ingots, and so forth. The result was that in many cases with big moulds they machined both ends, and it was insisted that they cast a head on the ingot moulds. From experience, he found that 9 in. of head was required to be cast on an ingot mould, so that when it was machined off, the casting was solid. Hematite was very liable to drawing. If there was no provision for feeding and a certain amount was machined off at the top, one would probably find a large draw-hole.

Type of Metal to Use

To a certain extent, manufacturers of ingot moulds were limited in the type of metal they could use, as there was the salvage aspect of ingot moulds to be considered Apart from that,

they would probably all agree that in order to deal with the repeated expansions and contractions an iron with a high total carbon content was necessary.

Various opinions prevailed respecting silicon and manganese. Some people went so far as to recommend a 1.5 to 1.75 per cent. manganese iron, but for his own particular practice he used an iron of about 0.6 per cent. manganese. He would recommend 1.6 per cent. silicon for larger moulds, and for smaller ones about 1.8 or 1.9 per cent. He felt that manufacturers would probably all agree that the ingot mould must have low sulphur and low phosphorus contents. In Sheffield they were allowed to reach 0.07 per cent. sulphur and phosphorus, unless salvage was essential. He wondered whether a closer grained material would assist to lengthen the life of the ingot mould.

In Sheffield the ingot moulds would have a very low combined carbon content, probably as low as 0.3 or 0.5 per cent. He thought that experiments might be undertaken with a view to ascertaining the maximum combined carbon content which was permissible, and also the degree of fineness of graphite that could be obtained to give better results. If research work could be undertaken in that direction, in conjunction with better treatment in the steelworks, some useful knowledge would probably be acquired.

Feeding the Castings

MR. BALLANTINE, speaking personally, said that machining the top of moulds was not necessary, but he thought to feed moulds was not advantageous. Taking mould section, he found there was a definite open matrix in the wall centre. There was no inner local defect showing due to lack of feeding. The wall section was quite definite, and showed the same characteristics in any other part of the mould. He believed the part showing the open matrix had a beneficial effect on the life of the moulds, simply because there was a cushioning effect.

The tendency towards moulds splitting in service was objectionable, and the very fact that they were not fed had proved beneficial. Mr. Roxburgh was manufacturing under entirely different conditions from those at the author's foundry.

MR. ROXBURGH said that usually it was an inverted type of mould when the head was cut off and the top surface was machined, which meant that the top side came to the bottom when in service.

MR. BALLANTINE agreed, but said that he cast the other way.

MR. ROXBURGH observed that the point was that they took the top part of the casting as cast, then turned it over, and all the pressure was at the bottom.

MR. BALLANTINE said that the inverted type of mould was cast in a similar way to that described in the Paper. He did not agree with the suggestion that the down-gates chased each other, and he asked if Mr. Roxburgh was referring to the duodecagonal type.

MR. ROXBURGH said he was referring to the big moulds. In the case of small moulds he only ran them from the bottom, and in such cases the gates would not chase each other.

MR. BALLANTINE said that he stepped the gates. He thought the gates chasing round created a swirling action, which tended to disturb the twelve points on a core of this type.

MR. ROXBURGH said that with a small mould they had a grip cut in the bottom. He wished to mention that he blacked all his cores in the green state and not in the dry state; because in the green state the sand was able to absorb the blacking better.

MR. BALLANTINE said that was also his practice. His point was that the sand core had very great advantages as contrasted with loam moulding with bricks. He was still of the opinion that the corner flaking could be eliminated. If it were possible to vent by means of a pricking rod from the inside to the outside, this would assist scaling. Owing to the very fact that bricks were not used, and the sand was of a definite texture, this trouble of scaling rarely arose. He had had a peculiar experience some time ago, when he was called to a works to see an 8-ton casting. The foundry wanted an allowance for the job. A complete shell came from the inside of the casting, adhering to the steel, and he learnt that this casting had run out when poured, and had been filled up again!

Size of Gates

Answering another speaker, Mr. Ballantine said he did not include the sizes of down-gates and in-gates, because every particular mould had different ratios. He was very pleased that the speaker had brought forward the point respecting the amount of sand. He always liked to have a safety margin in sand. Some of the older boxes gave 2 in. of sand, which was useless. In the case of any new boxes that were designed, there was a minimum of 5 to 8 in. of sand.

In the case of the large box, he believed there was a margin of 10 in. sand, which gave a very good cushioning effect. A binder was not required at all. If there was a fair margin of sand to work with, a great deal of trouble was eliminated.

He had found some fairly wide variations in regard to combined carbon contents. The fundamental necessity in any foundry practice was care in manufacture, quite apart from the metal used. The finest metal ever manufactured, if put into an inferior mould, would produce a defective casting, while quite ordinary metal put into a first-class mould would produce a serviceable casting.

MR. ROXBURGH, referring to combined carbon, said if a casting was to be maintained at a continuous temperature throughout its life, he thought that one could even use an iron with a mottled structure because there was no shock to contend with. When casting ingots in ingot moulds, if they were repeatedly cooled down and heated up again, the conditions were entirely different. In his opinion, for an ingot mould a low combined carbon content was definitely better. Perhaps the percentage could be increased a little more with a view to giving increased life. For continuous service he had made irons which had been quite mottled, where the combined carbon had been 1.5 or 2 per cent., and the life in service had been over two years.

MR. J. E. COOKE spoke with regard to the drawing of core boxes which had been jar rammed. Mr. Ballantine had emphasised the importance of the varnish. There was a tendency at the present time to attempt to save both time and money by the use of inferior varnish, in which gum or resin content impeded drying. Did Mr. Ballantine use the best quality varnish, and had he ever tried any substitutes for varnish on the coatings for the surface of his core boxes?

MR. BALLANTINE replied that he bought the very best varnish paint possible to obtain. He was not content with giving one coat; he gave three. He could effect considerable economies in production by the application of good quality varnish paint, and the patterns stripped easily. It was not an economic proposition either to put inferior varnish on the patterns or to scamp the timber. If he put good timber on, 2½ in. thick, he used good varnish paint.

(*Concluded from next column.*)

up-grade, and this is a point they must watch, but this increase is mainly confined to the U.S.A. at the moment, although Japan is taking a lot of copper. America, however, is looking after this and in Europe the rate of increase is not marked, for it had reached a high level last year. On the whole, it certainly seems as if copper were too high for safety at present.

Who Will Control Copper?

BY "ONLOOKER."

Following the announcement of unrestricted production in copper, an extremely interesting situation has developed which leads to the conclusion that a definite battle is being waged between the producers and the speculators. Nobody with any intimate knowledge of the commodity markets would say that a measure of speculation was detrimental to the conduct of affairs, but all would, probably, agree that events on the London Metal Exchange during the past few weeks have demonstrated the evils that arise when outside interests gain too much ascendancy over price movements in the market. If the provision of facilities for trading in futures is to lead to nothing more than a spate of gambling, then the sooner the opportunity is withdrawn, the better for all concerned. The primary reason for offering facilities of this kind is to enable producers and consumers to hedge their position, and in normal times this type of business predominates in Whittington Avenue with only a modicum of speculation which serves to keep the market alive and to brighten up the proceedings generally. Unfortunately, at the moment this "brightening up" has assumed somewhat the appearance of a firework display!

Cost Reduction with Increased Prices

It will be remembered that some months ago semi-official prominence was given to the fact that the Rhodesian producers would be perfectly happy to see electrolytic copper standing at £45 per ton, and presumably the other mining interests who are parties to the curtailment pact would be equally pleased with this. Since this announcement was made, however, there has been a considerable increase in the general level of commodity prices, including spelter and lead, but excluding nickel—whether justified or not will not be debated here—and it is reasonable to suppose that the copper producers have rather revised their ideas. Even so, the present price seems much too high, and an additional £5 added to the original idea of £45 would seem to be quite adequate in all the circumstances, as £50 for refined copper is a good round figure in the light of present day costs of production, which are, under modern methods, well below their pre-war level. Yet there are those who are talking the price of standard copper up to £60, which envisages a level of £65 for electrolytic. Whatever may happen to the price level, it may be taken as certain that, with standard at £50, a tremendous incentive is being given to output, which without restriction will rise steadily as the months go by. Already the statistical position is beginning to deteriorate with increasing world stocks, and this trend will continue during the present year. Of this it is felt that there cannot be any reasonable doubt.

Producers Dissatisfied

That the producers are determined to contest the situation with the speculators seems certain, for their only alternative is to hand over the control of the market to interests whose ends are best served by a succession of fluctuations in the price, only to be achieved by keeping up a series of rumours and counter-rumours calculated to keep everybody on tenterhooks of surmise. It cannot be doubted that the legitimate needs of consumption are covered by the existing rate of output, and within a very short time there will be a comfortable margin. To what extent will the producers feel justified in meeting the abnormal demand on the warrant market by selling in anticipation of their higher production? Trade demand is said to be on the

(*Concluded in previous column.*)

The Institute of Metals

PROGRAMME OF THE ANNUAL GENERAL MEETING

The twenty-ninth annual general meeting of the Institute of Metals will be held in the hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, from March 9 to 11. The following is a programme of the meeting.

Tuesday, March 9.

2 p.m.—Coach leaves St. James's Park Station, Broadway, S.W.1, for works visit to Kodak, Limited, at Wealdstone.

6.30 p.m.—Arrive back at St. James's Park Station.

8.30 p.m.—Members will assemble at Magnet House, Kingsway, the London offices of the General Electric Company, Limited, for a television demonstration. (Party limited to 120.)

Wednesday, March 10.

10 a.m. to 12.30 p.m.—General meeting. The report of the Council and the report of the honorary treasurer will be presented. The results of the election of the council for the year 1937-38 and of new members will be declared. The following Papers will be presented for discussion:—

"The Theory of Age-Hardening," by Marie L. V. Gayler, D.Sc.

"Modern Metal Spraying: Processes and Some Characteristics of the Deposits," by E. C. Rollason, M.Sc.

"The Effect of the Addition of Small Percentages of Iron and Silicon to a High Purity 4 per cent. Copper-Aluminium Alloy," by Marie L. V. Gayler, D.Sc.

"The Effect of Cast Structure on the Rolling Properties of Zinc," by L. Northcott, M.Sc., Ph.D.

"An Aluminium Statue of 1893: Gilbert's Eros," by Prof. R. S. Hutton, D.Sc., M.A., and R. Seligman, Ph.Nat.D.

12.45 p.m.—Members who so desire may lunch together at St. Ermin's Restaurant.

2 p.m. to 4.30 p.m.—The following Papers will be presented for discussion:—

"Directional Properties in Rolled Brass Strip," by M. Cook, M.Sc., Ph.D.

"The Resistance of Some Special Bronzes to Fatigue and Corrosion-Fatigue," by H. J. Gough, M.B.E., D.Sc., F.R.S., and D. G. Sopwith, B.Sc.Tech.

"Stress-Strain Characteristics of Copper, Silver and Gold," by J. McKeown, M.Sc., Ph.D., and O. F. Hudson, A.R.C.S., D.Sc.

"Creep of Lead and Lead Alloys. Part I—Creep of Virgin Lead," by J. McKeown, M.Sc., Ph.D.

"A Study in the Metallography and Mechanical Properties of Lead," by Brinley Jones, M.Met.

7 p.m. for 7.15 p.m.—Annual dinner at the Trocadero Restaurant, Piccadilly Circus, W.1.

The annual dinner will be followed by an informal social gathering of members and their friends. Mr. Marc Anthony, late of the Cossack Restaurant, Jermyn Street, will play light music on the piano "by request," but no formal musical entertainment will be given. The price of tickets for the dinner, exclusive of wines, is 12s. 6d. Application for tickets may be made now by members who desire to reserve seats or tables for the dinner. Members who have paid for tickets and, later, find that they are unable to use them, may obtain refunds by applying to the secretary not later than March 8. Tables (to seat 6-10 persons) will be reserved for parties making early application for tickets.

Thursday, March 11.

10 a.m. to 12.30 p.m.—The following Papers will be presented for discussion:—

"The Control of Composition in the Application of the Debye-Scherrer Method of X-ray Crystal Analysis to the Study of Alloys," by W. Hume-Rothery, M.A., D.Sc., and P. W. Reynolds, B.A., B.Sc.

"Alloys of Magnesium. Part IV—The Constitution of the Magnesium-rich Alloys of Magnesium and Silver," by R. J. M. Payne, B.Sc., and J. L. Haughton, D.Sc.

"The Solubility of Silver and Gold in Solid Magnesium," by W. Hume-Rothery, M.A., D.Sc., and Ewart Butchers, B.A., B.Sc.

"Alloys of Magnesium. Part V—The Constitution of the Magnesium-rich Alloys of Magnesium and Cerium," by J. L. Haughton, D.Sc., and T. H. Schofield, M.Sc.

The following Papers may be presented if time permit:—

"The Estimation of Grain-Size in the Region above 10^{-3} cm.," by R. A. Stephen, M.Sc., and R. J. Barnes, Ph.D.

"The Constitution of Silver-rich Antimony-Silver Alloys," by P. W. Reynolds, B.A., B.Sc., and W. Hume-Rothery, M.A., D.Sc.

The following works visits have been arranged:—

Party A.—1.45 p.m.—Coach leaves St. James's Park Station, Broadway, S.W.1, for a visit to the works of the Gramophone Company, Limited, Hayes, *or* the Associated Equipment Company, Limited, Southall.

6 p.m.—Coach due back at St. James's Park Station. ("Gramophone" party limited to 32; "A.E.C." party limited to 20.)

Party B.—1.45 p.m.—Coach leaves St. James's Park Station, Broadway, S.W.1, for a visit to the works at Merton of Fry's Die Castings, Limited.

5.30 p.m.—Coach due back at St. James's Park Station. (Party limited to 20.)

Party C.—1.45 p.m.—Train leaves St. James's Park Station for Stepney Green Underground Station to visit to the Anchor Brewery of Charrington & Company, Limited, Mile End Road, London, E.1. (Party limited to 60.)

(*Concluded from next column.*)

them in tens of thousands; no expense was spared on the equipment in the endeavour to secure the greatest accuracy, and yet an eccentricity of from 20 to 45 thousandths on an 11-in. brake drum represented the best that could be done. The attitude of the Inspector who demanded that the castings should be really accurate was quite unjustified, and, as Mr. Slater had indicated, it was important to lay the facts before the engineers so that they might ease the problem for all concerned. The difficulty at present was that no tolerances whatever were specified, and the position was very unsatisfactory, particularly in high production work. Castings could be made more accurately.

Vote of Thanks

MR. H. O. SLATER proposed a vote of thanks to Mr. Kain for his presentation of the Report. MR. H. E. HAND seconded the vote, which was carried with enthusiasm. MR. G. L. BAILEY briefly responded on behalf of Mr. Kain and himself.

B.I.S.F. Annual Dinner

The annual dinner of the British Iron and Steel Federation will be held at the Dorchester Hotel, Park Lane, London, on February 18, when the principal speakers will be the Rt. Hon. Winston Churchill, M.P., and the Rt. Hon. Sir Robert Horne, M.P.

Dimensional Tolerances

At a recent meeting of the London Branch of the Institute of British Foundrymen a discussion took place on Two Reports of Sub-Committees of the Technical Committee of the Institute. The Report on leaded gunmetals was presented by Mr. G. L. Bailey, M.Sc., and the discussion which followed was reported in our last week's issue. Below we print the discussion on the Report of the Malleable Iron Sub-Committee, "Dimensional Tolerances for Castings (with Particular Reference to Malleable Cast Iron)," which was presented by Mr. C. H. Kain.

MR. V. DELPORT (Branch-President) said that the endeavour to remove lax wording and to substitute unambiguous phraseology in specifications was in itself of the utmost value, quite apart from other aspects of the matter dealt with in the Report.

Brake Drum Tolerances

MR. H. O. SLATER congratulated the Malleable Cast Iron Sub-Committee upon its pluck in tackling the problem of tolerances in malleable iron. He recalled that about 20 years ago, when the motor industry was rather in its infancy, he had had to cast a brake drum of about 22-in. dia.; bearing in mind the slight distortion that was likely to occur during contraction after casting, and the distortion subsequent to packing in the oven and annealing, he suggested that tolerances of $\frac{1}{16}$ in., and so on, as mentioned in the Report, would be regarded by foundrymen as being very low indeed for such castings. Whether or not the shape of the casting would be anywhere near the shape of the pattern after it came from the oven depended very much in some cases upon the skill of the operator who packed it in the oven; it depended very much upon how and where he packed it, the density of the ore with which he packed it, and so on. Sometimes castings which were cast almost true to pattern had to be set after they were taken from the oven.

Mr. Slater said the Report gave the designer some lead and caused him to make due allowances for the difficulties arising in the casting of the metal. It was a good thing to arrive at a basis and then to allow sufficient room on that basis, as the Sub-Committee had endeavoured to do, for the designer, the foundryman and the consumer to reach agreement.

Possibility of Narrower Limits

MR. C. H. KAIN, in reply, said that, although Mr. Slater had implied that the tolerances suggested in the Report were too small, there were many others who, whenever tolerances were suggested, would suggest that they were absurdly large; when such people measured up their own castings, however, they often found that they were not nearly so accurate as had been thought.

Mr. Kain added that some brake drums to which he had referred were in grey iron, and the tolerances given in the Report for malleable iron would not apply to them. He gave, however, figures relating to two small brake drums in regular production from first-class patterns mounted in cast-iron plates fixed rigidly on a machine, with no vibrator to aid the stripping. In one case the nominal inside diameter was $10\frac{3}{8}$ in. The actual pattern size was 11.784 in.; on one casting the maximum diameter on the casting was 11.68 in., and the minimum diameter was 11.62 in., giving a variation of from plus 0.016 to minus 0.040. A large number of castings showed a maximum eccentricity of 60 thousandths and a minimum eccentricity of 20 thousandths; that was an average of $\frac{1}{32}$ in. on a drum of 11-in. diameter. He emphasised that no expense was spared in respect of the patterns. The drums were made by very prominent motor car manufacturers, who were producing

(*Concluded in previous column.*)

Metal Degreasing Prior to Vitreous Enamelling*

By Dr. N. R. HOOD

Introduction

The fabrication of articles from various metals in the modern tendency for the replacement of such materials as wood by metal, has increased the importance of the removal of grease from metal surfaces. It is inevitable during the process of manufacture of even the simplest article, that the surface should become contaminated with grease, and the removal of this grease is essential before any finishing process can be applied. For such processes as plating, painting or vitreous enamelling, the degree of cleanliness required is of a very high order.

Grease can be eliminated in a number of ways, which can be divided into mechanical and chemical operations. The most obvious mechanical method is the wiping of articles with fabric, but such an elementary method has undoubted disadvantages, as, after the first wiping, the fabric becomes dirtied and a clean surface cannot be produced by rubbing with a cloth already contaminated with grease.

Another mechanical method of cleaning is to subject the greasy article to the abrasive action of a sand blast. This method again has obvious disadvantages, as the sand particles used are bound to become coated with grease, and, further, many classes of articles cannot be subjected to such treatment, as the surface would be damaged and the final finish spoiled.

Grease Origin

The lubricants in common use in industry almost invariably consist of organic liquids, such as hydrocarbon oils of animal, vegetable or mineral origin, sulphonated oils, etc., and they may or may not contain inorganic material added to produce certain properties in the resulting oil.

Being organic materials, they will burn easily when subjected to high temperatures, and one obvious method of degreasing is to subject the articles to such a high temperature that the oil film covering the articles is burned or boiled away. If the temperature is sufficiently high, complete removal will occur, leaving only a residue of such inorganic material as may have been present on the metal surface or in the original oil. The process is in common use in the vitreous enamelling industry and is known as burning off. The metal surface after the treatment is completely grease free.

Another grease removing process which has been developed is the utilisation of the detergent properties of alkalis and soaps. In this case, the articles are immersed or sprayed with a water solution of the detergent agent and the grease is then removed by emulsification or saponification, or both.

The modern degreasing process, however, is the removal of grease by means of solvents. The obvious solvent at first sight is a petroleum spirit. This material has good solvent properties for the majority of oils and greases and is available throughout the world, but it has the disadvantage of being inflammable. The development of the use of chlorinated hydrocarbons for metal degreasing has overcome the inflammability trouble and metals degreased by these solvents are usually more perfectly degreased than by any other process.

Classification of Methods

It will, therefore, be seen that the degreasing of metal can, in general, be divided into three distinct classes, namely, degreasing by mechanical means, where the grease is removed by a form of abrasion; degreasing by the destruction of the grease by subjecting the articles to a sufficiently high temperature to cause combustion or volatilisation of the grease film, and degreasing by the use of chemicals, either alkalis or solvents.

The object of all processes is to render the surface finally into such a clean condition that subsequent processes can be applied without difficulty, and from this aspect the removal of solids with the oil and grease is a decided advantage. All systems are in use to-day in industry, but the methods having the widest application are those employing chemicals.

Sand Blasting

In the vitreous enamelling trade, enamelling is carried out either on cast iron, steel or iron sheet and oil and grease must be completely removed before the application of the enamel. With cast iron, which has a porous surface, the use of chemical cleaning agents, alkalis or solvents, is not desirable. The final cleaning of these surfaces must be carried out by some mechanical means, and that in general use is sand blasting or blasting with chilled shot. The desired cleaning is obtained by the action of this blast, and at the same time blemishes and irregularities are removed from the cast surface. Any chemical method applied to such articles would result in absorption of the cleaning medium into the pores of the metal and expulsion of the absorbed material during the subsequent enamelling processes, which would give rise to pimpling or other difficulties. In considering chemical solvents for this case, the loss due to the absorption alone would preclude the use of such cleaning agents, even if difficulties did not arise in subsequent processes.

Burning Off Process

There are certain fundamental points to be considered, because the success of the process depends entirely upon the subjection of the articles to a sufficient temperature to obtain complete combustion or volatilisation of the grease film. In order to obtain complete combustion it is essential that the operation should be carried out in an oxidising atmosphere, such as an air atmosphere, and this very fact produces oxidation of the metal surface, as well as grease destruction. Certain surfaces would show very serious deterioration by oxidation, and burning off could not be applied universally for this reason alone, but the system has certain application where it gives rise to decided advantages. In the vitreous enamelling trade, beading is a common requirement, and as the beading operation involves the turning over of the top edge of the metal in a press, the article at the conclusion of the beading operation is left in a state of strain, which may be removed by annealing. Destruction of the lubricant used occurs during the annealing process, and no further degreasing process is necessary.

In cases where annealing is not applied to close beaded work, burning off is the only satisfactory method of getting rid of the lubricant used in the turning over of the sheet, as any such bead forms what is tantamount to a seal around the top of the vessel, and cleaning liquids could not act upon the oil trapped inside the bead. The reason for this is that the rate of penetration of any liquid into this seal must be slow; in addition, once the bead is filled, the liquid inside remains stagnant and prevents removal of the grease by washing. The liquid trapped in this way remains in the bead when the article is removed from the bath, and gradually seeps out, leaving a stain consisting of grease and the chemical degreasing medium used.

If alkali has been used for the cleaning process, the residual alkali will be neutralised by the subsequent pickling process, but the oily lubricant will prevent efficient pickling of the surface at its point of contact with the metal. The use of chemical solvents has similar objections, but in this case the solvent is comparatively expensive, and the drag out would give rise to undue loss. Any slight internal stress is also released during the time of burning off, but radiation losses from such a high temperature process are also quite appreciable.

Loss of Pickling Acid

The loosening of oxide scale and rust is stated to occur during the heating, thereby simplifying the subsequent pickling process, but as an increase in the oxide present must have taken place, the quantity of material to be removed must have increased, consequently the time of pickling and the consumption of acid would be expected to show increases.

Another disadvantage is that, should the surface of the material be coated with non-combustible solids as well as grease, these solids will be left on the surface at the conclusion of the operation, and may give rise to inefficient pickling or other difficulties in subsequent processes. The application of burning off is thus limited, and can, in general, be said to apply only to close beaded work.

Alkali Cleaners

It will be recognised that cleaning by mechanical means and by burning off are methods only to be applied in special cases. Alkalis and solvents are much more universal in application than either of the two methods already mentioned. Both alkali and solvent cleaning depends upon immersion and/or spraying of the dirty articles in a bath containing the particular cleaning material in question. Alkali cleaners operate in aqueous solutions and are usually employed hot.

The fundamental factors to be considered in an alkali detergent process are:—

(1) The wetting and penetrative power of the solution.

(2) The presence of a suitable emulsifying agent in the cleaning solution to maintain any solids removed from the surface in a state of suspension and at the same time emulsify the oil removed.

(3) The strength of the alkaline solution and the ease of removal of such solution by subsequent water washing.

D

* A Paper read before the London Section of The Institute of Vitreous Enamellers, Mr. V. C. Faulkner presiding.

Other factors which affect efficiency are temperature, agitation and time of treatment.

Considering, in order, the factors mentioned, the first important factor is the wetting and penetrative power of the solution. It is essential that the surface to be cleaned must be wetted, and the solution, therefore, must have what is known as wetting power. No dirt can be affected by any aqueous cleaning liquid unless this dirt is first wetted and the wetting out of dirt and oil depends largely upon surface tension and interfacial tension between the dirt particle, the oil, the metal, and the alkali solution. The surfaces of all liquids are in a state of tension, and this phenomenon, which is known as surface tension, can best be explained by considering some examples. A needle can be floated upon water, and the surface of the water, although visibly depressed by the weight of the needle, does not break. This surface tension varies for different liquids, and can be increased; mixing of liquids invariably affects the surface tension of one or other. When a drop of oil is placed on a clean water-surface, it spreads over the surface because the tension of the clean water-surface beyond the oil layer is greater than the tension of the oily surface, *i.e.*, the addition of oil has caused a reduction in surface tension at its point of contact with the water, while the water surface surrounding the oil droplet retains its original surface tension, thus stretching the oil film to its limit. Interfacial tension is the physical force which keeps oil and water from mixing, and it determines the nature of the boundary between the liquids. A decrease of interfacial tension is essential before cleaning of metal by alkali can occur, and substances which, when dissolved in water, cause substantial decreases in interfacial tension between oil and water are essential in any alkaline cleaner.

Ameliorative Factors

Soap is one of the best known materials for producing a reduction in interfacial tension, but the formation of insoluble compounds with certain metallic ions, decomposition by acid solutions and salting out by strong alkali solutions limit its use.

The second factor to be considered is the emulsifying power of the cleaner. In the removal of vegetable or animal oils, the alkali cleaning agent functions owing to the fact that saponification of the oils takes place. This is tantamount to the conversion of the oil into a soap, and for this reason soap addition is not necessary when removing vegetable or animal oils with alkali solutions. With mineral oils, however, very little saponification can take place, although a trace may be present and efficient removal of oil and prevention of redeposition on the metal surface depends upon the efficient emulsification. In order to obtain these results some emulsifying agent is essential. Again, soap is the cheapest and most economical material for this purpose. If emulsification does not occur, then oil will be dispersed rapidly throughout the bath in the form of droplets and may accumulate on the surface to be redeposited on the metal during the passage of the work through the surface of the bath.

In addition to the emulsification of the oil the maintenance of solid particles of dirt in suspension is required, and here again the presence of soap gives the desired results. Soap solutions are colloidal, *i.e.*, they consist of particles so fine that they do not settle out under the action of gravity, and these particles are in constant motion throughout the solution. Absorption of these colloidal soap particles upon the dirt surface takes place in such a way that the colloidal particles force their way in between the dirt and the surface, thus removing the bond between the dirt and the surface. This frees the particle and as it is now surrounded by a colloidal film it will remain in suspension in the liquid. Any efficient alkaline cleaner, therefore, should contain a proportion of soap.

Referring to the third point, namely, strength of solution, the general idea that the more concentrated the alkaline solution, the better the cleaning results, is entirely incorrect. The most useful range of strengths is from 1 to 4 per cent. The number of materials commonly used for making alkaline solutions is very great, but the type of cleaning required prior to vitreous enamelling can usually be done with solutions containing caustic soda, sodium carbonate, sodium silicate and sodium phosphate, or mixtures of these compounds.

Caustic Soda Removal

Any article, when withdrawn from an alkali cleaning bath, will obviously be covered with a film of cleaning agent, and the ease of removal of this liquid depends upon the efficiency of the water rinse and the composition of the cleaning bath. Certain alkalis, such as caustic soda, are not easily removed by water, and complications are introduced in this way. Caustic soda will cling to the surface of metal and tend to pass through the rinsing section unaffected. On drying in the atmosphere the alkaline film remaining will absorb the CO_2, and give rise to a chalky deposit, which will tend to reduce the life of the pickling bath, as it will be neutralised at this stage. If the rinsing water supply is hard water, then the deposition of lime and magnesium compounds from the water will take place on the work during rinsing, and give rise to further difficulty during the pickling process. Certain additions are made to alkaline cleaning mixtures to produce ease of removal during rinsing; of these, trisodium phosphate is the most common. This material allows the alkaline solution to be removed readily during the rinsing process.

Requirements of Alkali Cleaners

An alkaline cleaning agent must, therefore, contain materials which will:—

(*a*) Assist wetting out of the metal surface.

(*b*) Produce a reduction in the interfacial tension between the oil to be removed and the water of the solution.

(*c*) Have the power of saponifying or emulsifying the removed oil.

(*d*) Keep removed dirt in suspension.

(*e*) Render the rinsing operation speedy and effective.

These results can in general be obtained with mixtures of simple chemicals such as caustic soda, sodium carbonate, sodium silicate, sodium phosphate and soap. There are, however, a very large number of proprietary brands of alkali cleaners which contain compounds added to give the above results, but it is beyond the scope of this Paper to discuss the merits or demerits of such mixtures.

It will be obvious that a process which depends upon so many complicated factors for its efficiency cannot be considered the acme of perfection as the breakdown of any of the factors mentioned, even to the slightest degree, would result in incomplete degreasing, which would immediately be reflected in the quality of the final finish. Alkaline cleaners, however, must be applied, wherever soap spun work has to be treated, and there is no other process which will remove soap lubricant so effectively.

Organic Solvents

The next process to be considered is the latest development in metal cleaning, namely, the use of organic solvents. This method of cleaning in contra-distinction to alkaline cleaning depends upon solution for its efficiency.

The ideal solvent cleaning process is one in which the dirty articles are subjected to a continuous stream of clean liquid solvent which dissolves and washes away the grease present. With such a process complete cleanliness is assured since all the lubricants are dissolved and the surface finally given a swill with clean solvent. The use of petroleum spirit, white spirit, etc., for this purpose involves a fire risk and for this reason these solvents cannot be used safely when hot, which is the ideal condition from the point of view of rate of solution of grease. If baths of cold solvent are employed then once a load of dirty work has been placed in the bath, the solvent is contaminated with a small concentration of grease, and on withdrawal of the load the film of liquid solvent left on the work must contain its grease concentration. When this film evaporates into the surrounding atmosphere, outside the apparatus, the small quantity of grease, being non-volatile, is left upon the metal surface. Evaporation of this film of inflammable solvent into the atmosphere external to the machine is undesirable, as it increases the fire and explosion hazards. There is another point to be considered here, and that is the rate of drying of the film. Obviously the longer the trip the faster the drying rate.

Trichlorethylene Plants

There is one group of non-inflammable solvents, however, that has been developed to a very great extent in the last few years, and these solvents, which are almost ideal as metal cleaning agents, are the chlorinated hydrocarbons. The best known of these liquids for metal cleaning is trichlorethylene. In addition to being non-inflammable, it has a vapour which is heavier than air, and it is these two properties which have enabled trichlorethylene to be developed as a metal cleaning agent.

Since the rate of solution of grease increases with an increase of temperature and the rate of evaporation from any surface also increases under these conditions, it is desirable that a solvent cleaning process should be operated at an elevated temperature, the most obvious temperature being the boiling point of the solvent. Under these conditions, rapid evaporation occurs as soon as the articles are withdrawn from the hot zone, and this evaporation will produce higher local concentrations of the solvent than the slower rate of evaporation from a cold surface where diffusion and dispersion by draughts can readily occur. If a cooling means is provided in the immediate vicinity of the drying off zone, then the evaporated solvent will be condensed on the cooling means, be recovered and returned to the system. All trichlorethylene degreasing plants operate in this way.

Fundamental Principles

In the consideration of the fundamental principle underlying the design of a degreasing apparatus operating on trichlorethylene or other chlorinated solvent, the first point to receive attention is the method of application of the solvent to the metal surface. The simplest type of plant involves the use of solvent vapour, and this fact has given rise to the common use of the term vapour degreasing. It must be stressed that the vapour produced by the evaporation of the solvent into a suitable container, has no degreasing action whatever when in the vapour phase, since grease removal depends upon solution in liquid solvent. Solution can be brought about either by dipping in the boiling liquid or by allowing condensation of solvent vapour to take place upon the cold article, by virtue of the difference in temperature between the article and the solvent vapour. Such temperature difference is essential before the process can operate. A film of warm liquid solvent is then condensed upon the metal surface, and as the liquid is condensed at the boiling point of the solvent the rate of solution of the grease is very rapid. The solvent condensed in this way is subjected to slight cooling by the contact with the cold metal surface, and the metal surface itself is gradually warmed up by the transference of heat from the solvent to the metal. The grease carrying solvent runs off the metal surface into the base of the container where it is re-evaporated and further condensation of solvent continues until the heat absorbed by the metal has raised the metal temperature to that of the solvent vapour. When this point is reached, no further condensation can occur, as the temperature difference between the work and the vapour has been eliminated, and, therefore, no further grease removal can take place.

At this stage, sufficient clean solvent has usually passed over the metal surface to have dissolved the whole of the grease film and also have given the surface a final wash with pure solvent. The process approximates to the ideal since the work is given a continuous wash with pure liquid solvent, and the metal surface after such treatment should be free of soluble grease.

Volume of Liquid Condensed

It can be seen that the process is a cyclic one involving the production of solvent vapour by boiling, the condensation of this vapour into liquid on a cold metal surface immersed in the vapour and the re-evaporation of the condensed solvent into vapour. Any dissolved grease or oil will remain in the base of the apparatus, as the boiling points of such materials are higher than that of the solution. It must also be pointed out that this so-called vapour degreasing process cannot remove anything other than grease and that its efficiency depends upon the heat capacity of the work. In order to obtain some idea of the volume of the wash produced by immersion of a piece of cold metal in solvent vapour the following data may be quoted:—

Ten sq. ft. of $\frac{1}{16}$-in. iron at atmospheric temperature, will condense 1.75 pints of trichlorethylene, before reaching the temperature of the vapour, namely 87 deg. C. Considering the same area of $\frac{1}{8}$-in., $\frac{3}{16}$-in. and $\frac{1}{4}$-in. iron plates, these will condense 3.5, 5.25 and 7.00 pints respectively or, in other words, a piece of $\frac{1}{8}$-in. thick plate, 5 ft. by 2 ft. in size when immersed in trichlorethylene vapour, will be subjected to a wash of approximately half a gallon of pure liquid solvent, which is ample for the complete removal of the usual quantities of oil and grease found on plates used in the vitreous enamelling industry. With materials such as copper and aluminium, the volume of condensate is reduced. Ten sq. ft. of $\frac{1}{8}$-in. thick copper will condense $3\frac{1}{2}$ pints of trichlorethylene while the same area of aluminium will condense only 2.5 pints of trichlorethylene.

Dirt Removal by Immersion

If the surface of the metal is covered with dirt as well as grease, then only that proportion of dirt which is mechanically washed off by the condensation action can possibly be removed. The fact that the surface is left in an entirely grease free condition as a result of the treatment renders the removal of residual solids less difficult since the dirt is left without a bond and it can very easily be removed by dusting or similar process. The action of the pickling solution is often sufficient to remove such solid contamination.

Where it is essential that the removal of solids should be carried out at the same time as the removal of grease, the process must be modified to incorporate a liquor wash, but in this case undue accumulation of grease and dirt in the liquor bath is prevented by arranging the system in such a way that the liquid bath is being continually renewed by clean solvent. The greasy work is first subjected to the action of vigorously boiling solvent followed by immersion in vapour. The liquid bath is fed with distilled solvent during the whole of the time of operation of the plant and an equal volume of contaminated solvent is drained away in order to maintain the equilibrium of the system. The dirty solvent enters an evaporation chamber where solvent vapour is produced, this is condensed on a cooling coil and returned to the liquor section of the plant. The grease and dirt are retained in the regeneration compartment.

Final Immersion Consideration

The reason for the final immersion in vapour must now receive consideration. It will be obvious that unless a load of work is left in the solvent bath for an abnormally long time, the bath must always contain a trace of grease, and when the work is withdrawn the surface after drying off will retain the amount of grease present in the evaporated solvent. Although this amount of grease will be very small it is essential that it should be removed and this is done by transferring the work to a vapour degreasing zone incorporated in the plant.

It should be noted that liquor degreasing differs from so-called vapour degreasing in that the heat capacity of the work has no bearing whatever on the efficiency of the process. With certain classes of metal which have an open grain, and, therefore, have the facility for allowing penetration of pressing oil, liquor degreasing is more efficient than simple "vapour" treatment. Another attractive feature of the solvent cleaning process lies in the fact that it is possible to degrease substantial quantities of work in a comparatively short time; as an illustration of this, plants can be designed to degrease one ton of $\frac{1}{8}$-in. thick steel plate in 15 to 20 minutes.

Plant Design

Equipment designed to operate on chlorinated solvents must possess certain features in order to prevent excessive solvent loss during operation. Any solvent degreasing plant should incorporate:—

(1) Some means of applying heat to the liquid.

(2) Cooling coils in the top section of the plant to provide means of control of the vapours produced by evaporation of the liquid. A collection trough is usually placed beneath such a bank of cooling coils.

(3) A sufficient distance between the top rim of the plant and the normal vapour level to reduce the natural diffusion loss to a minimum.

(4) Suitable cleaning doors to facilitate the removal of dirt and grease which may have accumulated during working.

(5) Some automatic means of control of the vapour level which could operate if a failure of the cooling water supply occurred.

With equipment designed to this specification the degreasing operation is one of the simplest imaginable, as it merely consists of immersing a load of work in the vapour or liquor until no further condensation upon the work takes place, and then withdrawing slowly with a pause in the coil zone above the vapour to allow adequate time for drying off to occur. If the work, by virtue of its design, tends to retain solvent, it must be placed in the cradle in such a way as to prevent this taking place, or a special design of plant must be installed in which the work is rotated.

The obvious errors of introducing or withdrawing work so rapidly that it gives rise to disturbance of the vapour, with consequent high loss, must be avoided, but, provided the operator displays reasonable intelligence, there is no reason whatever why a solvent degreasing plant should not be run satisfactorily and economically by ordinary process labour after only a few hours' instruction.

It has been proved in practice that the solvent degreasing process can be operated successfully and economically for the removal of both dirt and greases, and that the results obtained by this method of degreasing show a marked improvement over those obtained by any other degreasing process at substantially the same cost. Economy can often be shown by the adoption of this method when the whole of the finishing operation is considered.

It must be realised, however, that any solvent degreasing plant must be operated at substantially its maximum capacity in order to obtain the most economic results. Therefore, care must be taken to instal the correct type and size of machine for the required purpose.

Comparison of the material cost for a solvent degreasing process with the material cost of other processes may show that solvent is more expensive, but to obtain the true comparison consideration must be given to the increase of output, together with the increase in efficiency. With such a comparison, the solvent cleaning process invariably shows an economy over other methods of degreasing, and the results obtained are more uniform over any given period. The solvent cleaning process, therefore, has many advantages, and can be applied successfully to vitreous enamelling with beneficial results.

DISCUSSION

The CHAIRMAN (Mr. V. C. Faulkner) commented on the author's reference to the removal of "dirt" and asked him to explain exactly what he meant by that term. He pointed out that the composition of the earth's crust contained 52 per cent. silica and said that he could not see that the trichlorethylene process would have much action on that. He also suggested that where the author had mentioned shot in the Paper he had really meant chilled-iron shot.

DR. N. R. HOOD agreed.

Hydrofluoric Acid Cleaning

MR. W. H. WHITTLE (Chairman of The Institute of Vitreous Enamellers) said the lecturer had not tried to impress upon the meeting the great advantages of any one particular process over another. Mr. Whittle endorsed from his own practical experience most of the information given in the Paper, and said that sand and shot blasting each had its advantages and disadvantages. Grease burning had a definite advantage, particularly if the article had been cold set and wanted annealing. The other methods mentioned in the Paper had been found in the trade to have their advantages and disadvantages. One of the difficulties of the jobbing enameller or sign enameller in regard to degreasing was that he had to deal with a multiplicity of shapes and sizes. But in the bulk production of articles to a reasonably uniform size and shape, the alkali and solvent processes had various advantages.

Hydrofluoric acid had been used for cleaning cast iron and had made a particularly keen attack on silica; it gave very satisfactory results where castings had to be painted afterwards. He had not tried it for castings to be used for vitreous enamelling, but he did not see why castings so treated and subsequently hot washed should not be as good and the process as economical as those subjected to shot blasting.

MR. J. T. GRAY, referring to the trichlorethylene degreasing process, asked why, under certain circumstances there was a slight greenish streaking on the ware after degreasing by vapour trichlorethylene, notwithstanding that the plant was operated under the supervision of a service man acting for the supplier of the plant, and after the subsequent pickling had been correctly carried out these streaks were still visible.

Cleaning Irregular Shapes

MR. P. STONE suggested that probably some useful information could be imparted as to the lubricants which should be recommended to those who stamped or pressed the material to be enamelled and as to the type of cleaner that should be used to remove them. Some makers used only mineral lubricants and others used a soap compound, and there were many enamellers who could not understand why any one type of cleaner would not remove all those different lubricants. The author had stated that the alkali process was the only one to use for removing a soap lubricant. Perhaps, therefore, he could give some information as to the constitution of a cheap but efficient cleaner other than one of those that were supplied under trade names, sometimes at rather fabulous prices. There were many who knew by analysis what those cleaners contained.

One of the troubles in connection with vapour degreasing was that sometimes the solvent was cupped in a hollow in the surface of the material. Some people stated they could eliminate this trouble if the material were left in the tank for an hour. He had gathered from the Paper, however, that the quicker they were in the bath and out again the better. He had found in

practice that the combination of a caustic cleaner or other alkaline tank and trichlorethylene would give excellent results. He knew a firm which used the alkaline tank first and found that the grease used in pressing, which was a soap, came away freely to the top of the boiling liquor. After that they put the articles into the trichlorethylene and found that by this means failure of the trichlorethylene to act, was avoided, but they were much troubled by the cupping of the solvent due to the inability of the condensed liquid to flow away.

MR. A. R. EDWARDS, commenting on the author's statement that with 16 gauge material a certain evaporation occurred and that with heavier gauges there was a larger amount of evaporation, asked whether the trichlorethylene bath would be less efficient with lighter gauge material and whether a point was reached at which he would not recommend it.

Vapour Dispersion

MR. J. H. COUPE (hon. secretary, Southern Section of The Institute of Vitreous Enamellers) said that in his use of the trichlorethylene bath he had found that unless the metal sheets were used fairly soon after they were taken from the bath they suffered a certain amount of rusting. He had also found that in damp hot weather the action in the bath was less satisfactory than on an ordinary dry day. The plant removed the grease quite well, but in cases where the metal had been ground or polished, and where a certain amount of grit remained, that grit was very detrimental in later operations. He preferred to subject the articles to the action of trichlorethylene first and then the alkaline bath, which was the opposite order to that referred to by Mr. Stone.

Mr. Coupe added that it would be of great advantage to have a more efficient method than was at present available for trapping the rising vapours in the vapour degreasing process, there being an excessive amount of such vapours produced, in his experience. Apart from the difficulties at the plant itself, he had found that the vapours percolated into other departments and gave rise to difficulties, particularly where synthetic materials were being used; the vapours would get into the gas burners of the baking stoves and their effect upon the synthetic finishes was detrimental.

MR. E. J. GROOM asked whether it was possible to use a vapour degreasing plant to assist in the removal of graphite which had been used as a lubricant, as it had been found extraordinarily troublesome, particularly where subsequent pickling was necessary. In connection with some research on the corrosion of petrol tanks, in which it was found necessary to degrease the samples of tinplate used, trichlorethylene vapour was not particularly effective, whereas acetone was effective. The difficulty with trichlorethylene had been attributed to the effect of condensation in the pores of the tinplate, but he asked for Dr. Hood's views on the matter.

Author's Reply

DR. HOOD, replying to the chairman's question as to what was meant by the term "dirt," said that it meant any rubbish, metal, silica or solids of any kind that had accumulated on the component during its progress through the works. That dirt was held on to the material by the grease which was present. When the grease was taken away by vapour degreasing, the dirt that remained could be brushed off very easily. That could be demonstrated by degreasing a piece of sheet that was covered with solid particles and subsequently brushing it lightly; quite a cloud of dry dust resulted. Plants could be devised, however, in which the sheet was placed in a violently boiling liquid which would remove the vast majority of the dirt particles. At least, it would remove the dirt sufficiently to prevent any interference with subsequent processes to which the component was subjected. The removal of the dirt was due partly to the removal of the grease bond and partly to the scouring action of the liquid; it was not due to solvent action on the dirt.

He agreed with Mr. Whittle that hydrofluoric acid was probably one of the best substances known for the removal of adhering sand from cast iron. His personal opinion was, however, that it was a poor grease remover. He suggested that the most efficient method would be to remove the grease in the normal way and then to subject the article to treatment by hydrofluoric acid.

Eliminating Streakiness

Replying to Mr. Gray, he said that he had experienced the streaking phenomenon on Armco iron sheet. One firm had obtained very erratic results with a vapour degreasing plant, but only on Armco iron sheet. Examination of the sheet had shown that it had a very open grain, and from micro-photographs it was found that the pressing oil which had been used on the sheets (they were parts of gas stoves) had penetrated into the metal, so that after the vapour degreasing had been completed there was still a slight trace of oil left in the pores. In further experiments it was found that if the sheet were placed in boiling liquid before vapour degreasing, all the grease was removed and there was no residual trichlorethylene remaining in the pores of the sheet. Subsequent tests had shown that among 1,000 pieces of metal treated in that way, there was not a single reject, whereas in cases where the vapour degreasing process alone was used, the rejects amounted to between 7 and 10 per cent.

The problem of the lubricant that should be used was rather outside his province. The lubricants that he was concerned with generally were mineral oils, and he was not prepared to indulge in any discussion of the merits of sulphonated oils, and other oils of that nature. Certainly soap could not be removed by trichlorethylene, which, after all, functioned only because it was a solvent. The properties of trichlorethylene rendered it satisfactory for the purpose of degreasing, but soap was insoluble in trichlorethylene, and, therefore, the only way to remove soap was to use some cleaning agent, such as alkali, which would dissolve it.

Hollow Articles

Discussing hollow articles, Dr. Hood said that no matter how long such articles were left in the bath, the solvent would not evaporate. If the solvent were cupped in a depression in the article, it would remain there unless it was removed by tipping the article or by some other mechanical action. Generally a plant for dealing with small articles was devised to turn those articles over throughout the period of the degreasing. Again, if there were greasy depressions in a hollow article, then solvent would accumulate in these depressions. This solvent would contain the grease dissolved from the surrounding surface, therefore, the depressions would still retain some of their grease content when the metal was removed from the bath, the dirty solvent tipped out and dried off, unless the article was moving during the whole of the degreasing process, thus allowing the wash of clean solvent produced by condensation to proceed in the depression.

Dr. Hood agreed with Mr. Coupe that the best method of operation was to use trichlorethylene degreasing first and if necessary to use alkaline degreasing afterwards. He did not think that alkali degreasing should be used before trichlorethylene degreasing.

Replying to Mr. Edwards' question as to whether vapour degreasing would remove all the grease in one operation from a very light gauge material which was covered with a reasonable quantity of grease, Dr. Hood said it was necessary either to remove the material from the bath, allow it to cool off and then put it back again, or to subject it to the action of boiling liquid. He would recommend the use of boiling liquid; it was entirely independent of the gauge of the article, and in general it was a process that was preferable for application to light gauge material.

Rusting of Degreased Sheets

Rusting of steel would occur very rapidly after trichlorethylene degreasing, particularly in a humid atmosphere; this was due to the fact that the steel was entirely free from any grease protection. By means of a microscope one could almost watch the natural oxidation of steel proceeding. If a piece of bright steel which had been covered with grease were degreased and left for only an hour or two in a humid atmosphere, microscopical examination would disclose incipient rusting. Therefore, any article which had been trichlorethylene degreased should be processed within a minimum of time after degreasing.

Dealing with Mr. Coupe's suggestion that in damp weather the trichlorethylene process was not so satisfactory as in dry weather, Dr. Hood wondered whether there was any water present in the trichlorethylene bath or whether the articles were covered with water at the time they were put into the bath. Otherwise, he could not see any reason why articles which were degreased in dry weather should not also be degreased in damp weather. For articles which were wet with liquid water, vapour degreasing was no good, but boiling liquid should be applied. The reason was that trichlorethylene worked by solution, and where there was a globule of water the trichlorethylene could not get into contact with the grease.

Solids such as grit and abraded steel were definitely removed by boiling liquid. There had been many instances of that; if a material which had been treated in boiling liquid were wiped with a perfectly clean handkerchief, it could be proved that there was very little grit remaining, and any solids then present were extremely fine in character and therefore small in quantity.

Vapour Control

In certain trichlorethylene degreasing plants of very old design the control or trapping of the vapour was not very efficient, but nowadays the amount of cooling coil provided was determined scientifically in a degreasing plant, and was the amount, as determined by experiment, which resulted in the minimum loss, plus a large safety margin. Tests had shown that the concentration of trichlorethylene vapour above large plants 14 or 15 ft. long and 4 or 5 ft. wide was extremely small; indeed, it was almost undetectable at nose level. So that unless an operator dropped the articles in at a very violent rate, which obviously would disturb the vapour, there should be a minimum of loss, unless there was something wrong with the design of the plant or the manner in which it was operated. If trichlorethylene vapour passed through a gas flame, or was subjected to high temperature, it decomposed to form hydrochloric acid, and if hydrochloric acid were allowed to get into the oven it would have very serious effects. That was why it was always recommended that in a gas-heated plant a flue stack should be provided to take away the gas fumes; otherwise, there might be a trace of hydrochloric acid in the fumes which, if dispersed in the shop, would give rise to trouble. A workman might come to the conclusion that trichlorethylene was eminently suited for cleaning clothes, and he might take some out of the plant and leave it near a gas flame. The trichlorethylene would evaporate and get over the flame, producing hydrochloric acid, which would percolate throughout the shop, and the degreasing plant would be blamed. Dr. Hood said that he had experienced such a case.

In reply to Mr. Groom, he said that trichlorethylene would not remove graphite from large pressings. He would like to investigate the reason why, as mentioned by MR. GROOM, acetone had functioned as a grease remover where trichlorethylene had not. The only suggestion he could make at the moment was that the particular lubricant used was more soluble in acetone than it was in trichlorethylene.

Alkali Cleaning

MR. E. O. ROUNSEFELL (I.C.I. (Alkali), Limited), in reference to the application of alkalis to metal degreasing, pointed out that consideration should be given to the type of grease, fat or oil which was present on the metal to be cleaned and the appropriate alkali or mixture of alkalis should be used accordingly. Caustic soda was undoubtedly the most powerful of the commonly used alkalis and it was capable of removing animal or vegetable fats, greases and oils by saponification, *i.e.*, conversion into soaps. Caustic soda was, however, a poor emulsifier, and therefore alone did not adequately remove greases and oils of a mineral character since these could not be saponified. It was possible to overcome this failing by the addition of soap either as such or as resin, which in contact with a hot solution of caustic soda would be converted to sodium resinate and would act in a similar manner to soap.

A further disadvantage of caustic soda alone lay in its poor rinsing properties, so that there was a tendency for caustic soda to pass through the rinse and into the pickling bath along with the metal, where it would neutralise some of the acid which would otherwise be available for pickling. In order to overcome this difficulty it was necessary to introduce other products, such as sodium silicate and trisodium phosphate. By mixing sodium silicate and trisodium phosphate in the corect proportions with caustic soda, it was possible to produce an alkaline mixture which would rinse off well and thus avoid the wastage of acid in the pickling bath which would otherwise ensue. A combination of the products mentioned would give an alkaline mixture of generally satisfactory degreasing properties.

Enamel Remover

MR. B. B. KENT referred to the use of caustic soda in the molten form, not for removing grease but for removing enamel, and said there was difficulty in getting rid of the caustic soda. He asked whether it was possible to mix silicate or phosphate with the caustic soda in the molten form in order to effect ease of rinsing.

MR. ROUNSEFELL replied that he did not think so.

Complementary Processes

MR. E. A. JOHNSON did not regard trichlorethylene and the alkaline cleaners as competitive, but generally preferred to regard them, when used in combination, as a 100 per cent. cleaning procedure. If one cleaned first in trichlorethylene and then in an alkaline cleaner, one obtained 100 per cent. cleanliness, and an equivalent efficiency was obtained. It might be argued that the use of both would increase costs. He pointed out, however, that the number of rejects due to dirt, oil or grease often amounted to much more than perhaps any manufacturer would care to put into figures, and said that since he had used the alkaline cleaner as well as trichlorethylene, the proportion of rejects had been very much less than previously. With 35 cwts. of a proprietary alkaline cleaner, costing between £35 to £40, and 240 gallons of trichlorethylene costing £60 to £70, he could operate the number of units required for a year's schedule and could count on really efficient output. On the other hand, by using alkaline cleaners alone, one might lose more than £70 worth of materials, and increase labour costs due to grease or dirt having been present under a decorative or other necessary coating.

The Graphite Difficulties

He had encountered the difficulty of removing graphite from castings which had passed through the machine shop. On these castings the graphite had become more firmly bonded to the metal because of the oil used in the shop. The only manner in which he had been able to deal with the problem was to use first a trichlorethylene degreaser, then an alkaline wash, followed by a swill and acid pickling. If, as an experiment, one degreased a piece of metal thoroughly, then put a drop of oil on it and pickled the metal in a common acid solution, there would still be grease at that point. The metal might appear to be clean, but in reality it was not.

He had had to deal with some metal which had been treated with a rust-preventing compound consisting of approximately 30 per cent. petroleum jelly and 70 per cent. white spirit. Petroleum jelly was very difficult to remove, and even trichlorethylene would not remove it completely, there being streaks across the metal after treatment. If the metal were allowed to stand for two or three days after cleaning, rusting would occur in places where the metal was perfectly clean, but there was no rusting in places where the very fine concentration of grease had run down the metal. In the course of some experiments which Mr. Johnson had carried out, three pieces of metal were allowed to stand for three days after treatment. The first, which had been treated with trichlorethylene alone, was in rather a bad condition; the second, which had been treated with trichlorethylene and an alkaline cleaner, was in a still worse condition; and the third, which had been treated with only the alkaline cleaner, was the only one which was not rusted. This, then, proved that with first a trichlorethylene degreasing operation, followed by an alkaline wash, the metal was clean—hence rusting took place uniformly. Using only trichlorethylene, all grease would not be removed, and there was partial rusting. The result with alkaline cleaner alone proved the presence of a uniform distribution of grease still present on the surface. This, of course, acted as a rust preventive. Therefore, all metals perfectly cleaned should be processed as soon as possible after degreasing.

MR. J. H. GRAY asked if Dr. Hood would indicate the type of plant which should be used for dealing with stampings containing crevices. He pointed out that some enamellers had installed plant which would deal satisfactorily with flat plates, but they used that plant also for degreasing articles of all shapes, and when trouble occurred it was thought that the metal or the enamel was at fault, whereas probably the plant was not suitable for dealing with shaped articles. Bearing in mind Dr. Hood's point that a plant should operate at 100 per cent. capacity if possible, for economic reasons, Mr. Gray asked whether the lecturer would advise an enameller, who had to degrease both flat plates and articles of intricate shape, to instal a standard type of trichlorethylene plant and an alkaline bath, or to instal two different plants, one for the flat plates and one for the articles of intricate shape.

Mr. Gray also asked for information concerning the troubles arising from the incomplete removal of the degreasing solution; and he wished to know what the result would be on the enamel grip if the wrong type of plant were used.

MR. H. G. FRY, referring to the effect of trichlorethylene vapour upon the personnel employed on the plant, asked whether the effect was merely that of suffocation or whether the vapour was toxic.

Wetting Out After Processing

DR. HOOD agreed that it was essential, in the case of articles for plating as distinct from enamelling, that after trichlorethylene degreasing they should be treated by means of an alkaline cleaner. The reason was that trichlorethylene degreasing gave a grease free surface, but a grease-free metal surface would not wet out. That seemed paradoxical, but it was a fact. There must be some peculiar phenomenon occurring between the surface tension of water and the metal before the metal would wet out, and in order to render it capable of wetting-out it must be dipped into an alkaline bath. Where there was an acid pickling directly following the trichlorethylene degreasing he had not found that it was essential to adopt alkaline cleaning as well as the trichlorethylene process, though that might be necessary for special reasons in particular works. A combination of the two methods, however, usually gave 100 per cent. results, with considerable economic advantages over the use of either method separately. Petroleum jelly was not particularly soluble in trichlorethylene, hence the difficulty in removing it.

Degreasing Shaped Articles

Replying to Mr. Gray, he said that cup-shaped articles should be rotated during degreasing, and there was available a design of plant in which the articles were placed in a basket and were turned over during the degreasing process. The turning could be effected either by hand or by machinery, according to the output or the size of the articles. The treatment of very large sheets of complicated design presented a difficult problem, but usually there was some way of placing the sheets so that draining would occur.

In as much as it was essential, from the economic point of view, to operate a trichlorethylene plant to its maximum capacity, Dr. Hood suggested that it was desirable for an enameller who had to deal with varying quantities of work of varying types to instal two plants, probably one in which he could rotate the work, and another for dealing with straight work. If possible, the work should be allowed to accumulate during part of the day, so that the plant could be operated at maximum capacity for an hour or so. That was far more economical than to start up the plant at, say, 7.30 a.m. and to allow it to run all day, with various people occasionally dipping in work.

No Toxic Action

The effect of trichlorethylene vapour upon men and animals was purely one of anæsthesia. One could not breathe trichlorethylene and oxygen at the same time, and trichlorethylene vapour was an anæsthetic. Results had been published of experiments on rats, dogs, mice and other animals, but so far there was no evidence that trichlorethylene had any chronic toxic effect whatsoever. If a person were rendered unconscious through breathing trichlorethylene vapour, he would be taken into the air in order to recover from the anæsthetic effect, and would suffer no after-effects. He might feel just a little sick, just as one did when recovering from any other anæsthetic. Diseases such as toxic jaundice did not occur through exposure to trichlorethylene vapour.

Vote of Thanks

The CHAIRMAN commented that Dr. Hood was not only a very high grade scientist, but could also occupy the Bench in a judicial capacity, for he had held the balance between the two main processes extremely well.

The Paper was of extreme interest, and he proposed a hearty vote of thanks to Dr. Hood. This was seconded by MR. BRADLEY and carried.

DR. HOOD, in a brief reply, said that all who wanted to discuss the problems of degreasing at their works would be well advised to get into touch with the representatives in their area, and he himself was always available.

MR. J. H. COUPE proposed a vote of thanks to Imperial Chemical Industries, Limited, for the hospitality extended to the Institute and its members. He commented that the meeting was the best attended since the Institute was formed. The vote of thanks was accorded with acclamation.

MR. TODHUNTER (Imperial Chemical Industries, Limited) responded, and said that the occasion had afforded the Company very great pleasure. Those connected with the selling side of the organisation, he said, were concerned to make profits for their shareholders and also to sell to their customers the very best apparatus for their purpose. Dr. Hood and his associates had spent a great deal of time on research in order to help them to fulfil that object. Customers, who were also the Company's friends, could help tremendously in that direction, and a discussion such as that which they had enjoyed at the meeting carried them all a step forward.

Mill Room Practice*

By B. B. KENT

As the porcelain enamelling industry grows, the need for definite standards and methods of scientific measurement become more evident. In spite of the lack of tangible standards, however, the industry has made considerable progress during the last three or four years. To maintain this high standard, it is now necessary to develop scientific and commercial tests and to define the many loose terms at present in use, for example, the terms "acid-proof" and "acid-resisting" frit may mean anything from being indefinitely resistant to hydrofluoric acid, to withstanding the action of lemon juice for 10 minutes. Enamellers purchase "opaque" and "semi-opaque" frits, but outside the laboratory of a university these terms have no exact meaning. At present The Institute of Vitreous Enamellers is exploring every avenue with a view to beginning research in this country on the various phases of enamelling, but as enamellers have such definite rules and standards on which to work as those, for instance, available to the motor vehicle industry, the need for accuracy, cleanliness and exact control in every phase of enamelling cannot be over-emphasised. These remarks are directed particularly to the mill room and mill room control.

What is a Mill Room?

It will, perhaps, be advisable to define a mill room. Obviously, it is a department where the enamels are milled, but, in this Paper, it is regarded as that department which receives the purchased or manufactured frit and issues it to the sprayers in slop form ready for use. It therefore covers the milling operations, storing, checking and colour matching of the prepared enamel, as well as the storing of standard colour samples and milling data. It is considered, also, as a suitable place for the storing, checking and cleaning of spraying equipment and the handling of pickle control apparatus.

A mill room, to be efficient, must not be placed haphazardly in an odd corner of the enamel plant where it is thought a few mills might be conveniently put down, but should be a separate department entirely distinct from the plant, accessible only to the staff actually engaged therein. It should be well lighted and ventilated and provided with a door which can be locked when the staff is not on duty.

Possibly the greatest handicap in most mill rooms is lack of space. When building a new plant, therefore, ample provision should be made for possible future extension. As cleanliness is the order of the day in this department, the walls, if possible, should be lined with white ceramic tiles, whilst the floor should be of concrete, and special care must be taken to provide adequate drainage facilities. The floor should preferably slope towards one or more sump holes, and be provided with open gullies.

Eliminating Waste

Many enamel plants experience much trouble through the choking of the main drainage system with waste enamel as, however careful the operators may be, waste must occur during the process of cleaning guns, bins and mills. One method of overcoming this trouble is to drain the overflow from the sump *via* a long open gully before discharging into the main drain. If the sump hole is then cleared out at regular intervals, only a small quantity of enamel will flow out through the discharge gully and be deposited before reaching the main drain. In addition, apart from the saving of trouble and expense in clearing drains, this waste can be recovered and refritted. The author has found that even a mixture consisting of cast iron, sheet iron, ground coat and acid-proof frits produces a surprisingly good frit when refritted.

As well as the necessary grinding mills, this department should be provided with two or more large sinks, weighing platforms and scales, magnetic separators, electric sieves, storage bins and, if possible, a small electric or gas muffle for testing. Shelves and cupboards should be fitted for storing colour oxides, setting-up materials and other chemicals with a small desk for the keeping of records and milling formulæ. If the plant is handling both sheet iron and cast iron enamels, it is advisable to divide the mill room into two sections, each having its own mills, sieves and magnetic separators. Certain staff should then be delegated to each department under the control of a mill room foreman. Naturally, the most important equipment is the grinding mills, and these are usually ball mills of the batch type. In design and construction the ball mills used for vitreous enamelling are not essentially different from those used in allied trades, such as the pottery industry. Obviously, the enamel must not come into contact with any metallic part and the mills, therefore, are usually lined with porcelain tiles or blocks of the interlocking type set in Portland cement, whilst the outlet cover is also protected by a porcelain block.

Mill Equipment

The number of mills required will depend entirely on the size of the plant and the work upon which it is engaged, but, in a plant of, say, four or five muffles undertaking both sheet iron and cast iron work, the following equipment is suggested as adequate:—Two 1,000-lb., four 300-lb., four 100-lb., four 50-lb., four 20-lb. and four 10-lb. mills. This equipment, however, depends entirely upon the class of work being undertaken and, in a number of cases, it may be possible to operate more 1,000-lb. mills and a lesser number of 300-lb. mills. Economising on mills is not good practice, and cannot be considered a genuine economy. If separate mills be not used for each type and colour of enamel, the labour entailed in washing out, owing to a change of colour or type of enamel, and the ensuing waste of material will soon more than offset the installation economy.

These mills should be mounted on pedestals. It has always been a matter of amazement to the author that the suppliers invariably provide supports which are far too small, so that the mills have to be built up on concrete blocks to give the clearance necessary for unloading. If possible, each mill should be provided with a separate motor, either gear or Tex-rope driven, although the provision of stand-by line-shafting in case of breakdown is useful. The latter method, however, is not advocated, as it tends to aggravate one of the enameller's greatest troubles—dust. It has one advantage, in as much as the direction of rotation of the mill can be easily reversed by driving with a crossed belt, thus often lengthening the life of the mill lining.

It will be found that valuable floor space will be saved if the pot mills are mounted in racks against one of the walls. When constructing a mill room, it is an advantage to place a steel joist running over each mill which not only facilitates the mounting of the mill, but enables it to be easily removed for relining when occasion arises.

Loading the Mills

It is modern practice to load mills to three-quarters of their capacity, with 45 per cent. grinding agents and 30 per cent. frit. Assuming the mill to be new, it is first necessary to charge it with a small quantity of sharp sand and water and run it for, say, two hours. This operation will free it from any foreign matter, such as cement, etc., and, after a thorough washing out with water, it is then ready for use.

The mill can now be loaded with either pebbles or porcelain balls. The best pebbles for this purpose are found on the foreshore at Dieppe, and can be obtained, suitably graded, very cheaply in this country, which is probably the reason why the use of the more expensive porcelain balls, generally utilised in America, has not become more popular in England.

The pebbles or balls should be introduced gradually into the mill, until it is nearly half full, care being taken not to damage the porcelain lining. Next must be introduced the frits, colour oxides, opacifiers, etc., and, lastly, the required amount of water. The order of loading the solid ingredients is particularly important, and it is best to charge half the frit, add the oxides, etc., and then the remainder of the frit. If the oxides be added last, there is a risk of them becoming lodged in the opening cavity, with the result that the batch will be off-colour. All materials must, of course, be carefully weighed and entered in a special log book provided for the purpose before being checked into the mill. It is a safe policy to have each batch verified by the mill foreman. The water may be measured by weighing in a pail on a platform weigher, but a more satisfactory method is to have a graduated cylinder on the wall above the mill leading from which is a rubber tube that can be inserted into the mouth of the mill. A visible glass tube against the cylinders is graduated in lbs., and it is thus a simple matter to introduce, say, 20 or 30 lbs. of water into the mill by operating a small tap.

Whichever method is used, the danger of rusted pipes should be guarded against and it is always best, therefore, to employ galvanised pipes. Many imperfections in finished ware can be traced to impurities in the water supply and if the latter is exceptionally hard, a water-softening plant is advocated. The mill should then be rotated once or twice by hand and then started up. The starting time should also be recorded in the log book.

The time required to reduce the enamel to the necessary fineness depends on several factors, such as the size of the mill, the capacity to which it is filled, speed of the mill and type of enamel.

Operating Speeds

It will be found on reference to text books that the following approximate speeds are usually given:—1,000-lb. mill, 15 to 20 r.p.m.; 300-lb. mill, 30 r.p.m.; 100-lb. mill, 35 r.p.m.; 50-lb. mill, 40 r.p.m.; 20-lb. mill, 50 r.p.m.; and 10-lb. mill, 60 r.p.m., but, in the author's experience the speed of operation is quite immaterial as long as the enamel is not overheated. Whilst on a recent tour of a number of American enamelling plants, special note was made of mill room operation, and it was found that, in a number of plants, owing to high production, the mills were running at well over double the theoretical speeds. In more than one plant, all mills were built over a trough and cold water was sprayed on to them continuously to prevent overheating, the mills being provided with large enamel plates to prevent water splashing into the mill room. It was, in fact, claimed that enamel is considerably improved by this method, and when unloaded from the mill is practically at normal temperature.

Grinding time is usually measured in hours, but an alternative method is to fit a revolution counter to the mill. It is exceedingly important that enamels are ground to a consistent fineness. Great care should be taken not to over-grind the enamel, as a total loss will often result. The speed at which the enamel is ground down becomes more rapid as the milling proceeds, *e.g.*, if the milling time for a certain enamel is, say,

(*Concluded on page* 126.)

* A Paper read before The Institute of Vitreous Enamellers in Manchester, Mr. W. H. Whittle presiding.

STANTON-DALE
REFINED PIG IRON

Three typical analyses

	Total Carbon	Silicon	Sulphur	Phos.	Mang.
Motor-car cylinders	3	1·8-2·2	·05	·3	·5
Hydraulic Work	3·2	1·5-1·8	·07	·4	·5
Gas and Marine cylinders	3	1·3-1·6	·07	·5	·5

Stanton-Dale is a low total carbon pig giving close-grained, grey iron castings of great strength and toughness. Seven standard grades are available, and we can also supply to customers' own requirements without extra cost.

The Stanton Ironworks Company Limited, Near Nottingham

The Largest Producers of Foundry Pig Iron (for sale) in Great Britain

5 hrs., after 4¾ hrs. it may be at 12 units, while an additional 10 min. of grinding may reduce it to three units and a further 15 min. will render it too fine for use.

Fineness Determination

The following method of determining this unit fineness is now almost universally used, and is a distinct advance on the old guesswork method. Units are used rather than grammes or ounces, since the specific gravity of different enamels varies considerably, and it would be necessary to have instruments graduated in a different way for enamels of varying specific gravity. This standard test is undertaken in the following manner:—

Fifty m.l. of the partly ground enamel are taken from the mill when it is estimated that it is nearly at the requisite fineness, and thoroughly washed through a 150 mesh sieve until no enamel can be detected in the washings. The residue is then thoroughly dried. A graduated tube, marked in units, is provided, and the residue is then put into the tube, when the quantity can be read as a direct reading in units of fineness. The enamel is therefore said to be ground to so many units. Experienced operators will be able to produce an enamel of the required fineness by repeating this procedure two or three times.

Unloading Technique

When the enamel is at the required fineness, the mill is ready for unloading. The mill is stopped, the porcelain-lined cover is removed from the opening and an unloading tap affixed. The mill is then rotated until the tap is immediately over a receptacle before it is turned on. Force should not be used when removing the milled enamel and, on no account should rods or the like be inserted. It is possible, however, to speed up the emptying by connecting an air pressure line to the mill. The pressure should not exceed 5 to 10 lbs. per sq. in. but this method is not advocated owing to the risk of impurities, such as oil vapour, in the compressed air.

Although the correct procedure is then to place the enamel in suitable receptacles to age, in general practice there is usually a queue of sprayers waiting for it at the mill room door, so that this part of the milling operation is missed. Varying explanations of the phenomena of ageing are put forward, but the particular advantage gained is apparently the cooling of the enamel to the required working temperature, and the freeing of entrapped air. It has also been stated that the organisms of the clays change during the process of ageing. It is, however, an undeniable fact that all enamels, with the exception of certain acid-proof enamels which show definite signs of deterioration, are more stable and consistent when aged.

In the foregoing it is assumed that enamel to a definite colour formula is being prepared, but should it be the first batch of a new or a special colour, further tests will have to be made to check the colour. The only method is, of course, to fire a small sample, preferably in the mill room experimental muffle, and compare it with the standard sample. A correction in colour is achieved by adding further definite quantities of the oxide. A new colour is usually treated as an experimental batch and prepared in a pot mill, and, from these figures, it is a simple matter to calculate the formula for, say, a 1,000-lb. or 300-lb. batch.

Colour Matching

Too much attention cannot be given to the all-important subject of colour matching, as nothing is more annoying to a client than to find that his castings or sheets have been returned either not matching his original sample or varying from one another, and if a few sample plaques are taken, this pitfall will be avoided. In the Sterling Manufacturing Company's plant, cast-iron or sheet-iron test plates known as colour control plaques, are made for every batch of new colour prepared and referenced to the corresponding entry in the log book. These plaques are stored in a special cabinet, by reference to which it is a simple matter to find the required colour and the reference to the milling formula.

Owing to the variation in daylight, all colour matching should be undertaken by means of electric daylight lamps, as almost incredible variations in colour will occur if some enamels are matched at night and some during the day. Colours are, of course, obtained by the addition of various metallic oxides and special care should be given to these materials. The most satisfactory method is to provide a number of varying sized glass jars, suitably labelled, and to place in them the colour oxides as soon as they are received from the manufacturer. Unfortunately, no uniformity has been adopted by the various manufacturers, so that it is important to mark upon these jars the maker's name and his reference number. It has often occurred to the author that a standard range of oxides could be prepared and a chart issued giving the colours that can be obtained by mixing various proportions, so that, from about six colours, any intermediate colour could be obtained.

Maintenance of Mills

At regular intervals the pebbles or balls should be removed from the mill for examination, the small and broken ones being discarded, together with all other foreign matter with which they may have incidentally become contaminated. At the same time an inspection lamp should be inserted into the mill and an examination made of the lining.

It is not proposed in this Paper to give the various methods of setting up enamel, or details of its specific gravity, viscosity, etc., as these subjects will be dealt with in another Paper, but as probably next in importance to fineness is weight per given volume, a few words will not be out of place. Spraying equipment and local conditions will determine what this figure should be, but an average is 38¼ ozs. per pint, which figure can be obtained by adjusting the water content of the enamel before it is issued to the sprayers.

It cannot be too strongly emphasised that absolute accuracy in the control of enamel slip is necessary. If high grade work is being undertaken, the sprayers are entitled to have issued to them enamel in perfect condition, and they should not, in any circumstances, be allowed to water it down, dope it, or set it up. In other words, enamel as issued from the mill room should be in the exact condition for spraying. However, in the case of ground coat enamels, the condition will vary after it is issued, owing to use and variation of temperature, but any alteration required should only be made by the dipper and checked by the mill room foreman.

It has also been mentioned that the mill room is considered to be the correct department for the cleansing and maintenance of spray guns and for the control of the pickle tanks. It is suggested, therefore, that a record be kept of all the guns, showing their serial number, and that they should be issued to specified sprayers. At the end of each shift the guns should be returned to the mill room and given to the person responsible for their maintenance, while any defects developed during their use should be brought to his notice to enable repairs to be effected whilst they are being cleaned ready for use again. It is advisable to keep in stock at least two spare guns and an assortment of spare parts. A satisfactory method is to keep the guns in a glass cabinet, a definite hook being allocated to each, which simplifies both the issue and return of the guns and their inspection by the foreman. It can be readily noted if any are missing.

The pickle control apparatus, such as pickle pills, beakers, stirring rods, etc., should be kept in the mill room and, at least once a day a test should be made on the acid and alkali tanks and a report entered in the log book.

It is once again emphasised that cleanliness is one of the most important factors in enamelling, and it must be remembered that there are no short cuts if first class results are to be obtained. The mill room may be looked upon as the heart of the enamelling plant and even if high grade frit is purchased and expensive plant installed, unless due care and attention is paid to the milling of the enamel, it is impossible to produce a high grade finish.

In conclusion it is emphasised that the continual changes in the make of frit and colour oxides used should be avoided. After those most suited to one's requirements have been found further changes should not be made. If the frit is purchased from a specialised maker one brand only should be used. Various makes should on no account be mixed.

Short-Cycle Annealing

Mr. J. B. Nealey, writing in a recent issue of "Industrial Heating," makes the following recommendations for the preparation of irons which will anneal in a shorter time than is usual in ordinary practice.

(1) The silicon range should be raised from 0.9 to 1.0 per cent. to 1.5 to 2.0 per cent. This step may entail different foundry practice, but some of the larger foundries are successfully manufacturing irons of this composition in large tonnages.

(2) Controlled atmospheres must be used in annealing, thus eliminating the necessity for inert packing material.

(3) Higher superheating temperatures must be adopted in melting the irons.

To illustrate these points an iron containing 1.4 per cent. carbon and 1.7 per cent. silicon was made in an electric furnace with a superheating temperature of 1,550 deg. C. This iron was completly annealed in a gas atmosphere in a total time of 6.5 hrs. without any scaling or decarburising. The tensile strength was 26 tons per sq. in. and the elongation was 12.5 per cent. The most fruitful field for research on this subject would seem to be in investigating further the effect of the melting and casting practices on the annealing characteristics of the irons.

South African Foundry Developments

The Standard Brass, Iron & Steel Foundry, Limited, of Benoni, South Africa, is doubling the size of its machine shops, and the City Engineering Works of Pretoria are building a new pattern shop. A new firm, Cornthwaite & Jane (Pty.), Limited, is to be established in Germiston at Industries East. The plant is to make reduction gear castings. It will operate an electric furnace, and is to be entirely modern. The offices are of a circular design, something like the spokes of wheel, with the general office forming the hub. Thus corridors will be eliminated. Mr. Stanley Cornthwaite is a Maphin medallist of Sheffield University, and he has practised his profession as a metallurgist in Sheffield, Norway, and in recent years in South Africa.

Scottish Pig-iron Trade Wages

The joint secretaries to the pig-iron trade of Scotland have been informed by the accountants that the certified returns for October, November and December made by the employers show an average net selling price of £3 14s. 9.44d. per ton. This means that there will be an increase of 3 per cent. in the wages of the workmen on basis rates.

USE BRITISH ENAMELS

BY using British Made enamels you bring about the regular and direct employment of your fellow countrymen. You help to relieve the burden of taxation and to increase the growing prosperity of this land. Expansion of trade in British Enamels brings benefit to all classes of industry; from those who supply the raw materials to those who design the machinery which transforms them into the finished product.

Buy British Enamels, and to be sure that you get the best – Buy Blythe.

Blythe ENAMELS

Blythe Enamels are consistent – they do not vary from batch to batch. They represent the finest value in enamels that you can obtain the world over and they are British throughout.

BRITISH MATERIALS, LABOUR & MANUFACTURE.

BLYTHE COLOUR WORKS Ltd.

CRESSWELL, STOKE-ON-TRENT.

RB

The Week's News in Brief

Trade Talk

ANOTHER BLAST FURNACE was blown in by Shotts Iron Company, Limited, last week.

THE STAFF OF THE Coltness Iron Company, Limited, held a social and whist drive last Saturday.

THE LONDON OFFICE of Switchgear & Cowans, Limited, has been transferred to 85, Gracechurch Street, E.C.3.

THE HARDWARE AND ENGINEERING SECTION of the British Industries Fair will be held in Birmingham from February 15 to 26.

A THIRD BLAST FURNACE is to be erected at the Margam, Port Talbot, works of Guest Keen Baldwins Iron & Steel Company, Limited.

THE CESKOMORAVSKA KOLBEN-DANEK ENGINEERING COMPANY, of Prague, has received a contract for the supply of further tractors to the Turkish Army.

THE DUKE OF GLOUCESTER will visit the engineering and hardware section of the British Industries Fair at Birmingham on February 16, the day after it opens.

THE DIRECTORS of Qualcast, Limited, Derby, propose to increase the capital of the company to £325,000, by the creation of a further 500,000 ordinary shares of 5s.

GLENFIELD & KENNEDY, LIMITED, Kilmarnock, have received a contract in connection with the water supply scheme at Carron of the Stirlingshire and Falkirk Water Board.

A FIRE OCCURRED last week at the Vulcan Ironworks of McGregor Bros., Limited, in Bridgewater Street, Leigh, Lancs. Little damage was done and business will be carried on as usual.

A CONFERENCE OF TYNESIDE local authorities has been called for to-morrow to protest against the extension of a steelworks at Scunthorpe, Lincolnshire, by the United Steel Companies.

RESOLUTIONS INCREASING the capital by the creation of 600,000 new ordinary shares of £1 each and issuing 400,000 as a bonus on the basis of two for every three held were passed at a meeting of Murex, Limited, last week.

A CONTRACT FOR A 15,000-ton oil tanker for London owners has been secured by Swan, Hunter & Wigham Richardson, Limited, Wallsend. The engines, of the Swan, Hunter-Doxford type, will be built at Swan, Hunter's Neptune Yard, Walker, Newcastle-upon-Tyne.

SCOTTS' SHIPBUILDING & ENGINEERING COMPANY, LIMITED, Greenock, have received orders for two cargo motorships for Liverpool owners. The vessels will each have a deadweight tonnage of 8,000, and the propelling machinery, which will consist of Diesel engines, will be constructed by the builders.

LAST SATURDAY the employees of Alex. Findlay & Company, Limited, Parkneuk Works, Motherwell, held a social. Mr. John Macmillan, the chairman, referred to the pending departure of Mr. David S. Crawford, the works manager, and Mr. Robert Baillie, on behalf of the employees, made a presentation to Mr. Crawford.

A GENERAL MEETING of the Sheffield Society of Engineers and Metallurgists will be held in the Mappin Hall, St. George's Square, Sheffield, on Monday next, February 8, at 7.30 p.m. A Paper, "Some Technical Aspects of Tinplate Making," will be given by Principal C. A. Edwards, D.Sc., F.R.S., of University College, Swansea.

THE ANNUAL DINNER given by the Carron Company to their staff was held in the Dobbie Hall, Larbert, recently. Mr. George Pate, O.B.E., J.P., manager, presided, and was supported by Mr. F. L. Burder, chairman of the company; Mr. C. M. Brown, W.S., secretary; Dr. H. H. Brown and Mr. H. E. White. Mr. Pate referred to recent installations to improve output and efficiency, and also to the purchase from the Alloa Coal Company of their Stirlingshire assets.

SIR WALTER BENTON JONES, chairman of the United Steel Companies, Limited, announced last Thursday that his company is to spend £3,500,000 on new plant at the Appleby Works of their Scunthorpe, Lincs., branch during the next few years. The company is to build a complete new iron and steel works next to the existing Appleby Works, and this will include four new blast furnaces, duplication of the Appleby steel plant, new coke ovens, a new sintering plant and a new gasholder. When the full scheme is completed, the annual capacity of the Scunthorpe works will be 1,000,000 tons of pig-iron and 1,000,000 tons of steel.

RECENT ORDERS obtained by the machinery department of Edgar Allen & Company, Limited, include two rotary dryers for an important British company; a rotary dryer, dust collecting plant, and table feeder for West Australia; two electric furnaces, each of 10 tons capacity, and important extensions of a rotary kiln for a large British works. Other orders received by the same department include a rotary kiln, 50 ft. long by 5 ft. 6 in. dia., for Murex, Limited, of Rainham; a further rotary kiln, measuring 40 ft. long by 4 ft. dia., for the same firm; and two No. 4 Schulthess lime hydrators, complete with feed tables, etc. These latter have been ordered on behalf of the Union Lime Company, Limited, for shipment to South Africa.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Modern Galvanisers, Limited.—Capital, £2,500. Directors: H. Shillitoe, "Westwood," Potters Bar, Middlesex; G. R. T. Shillitoe.

Amalgamated Merchants, Limited, 14, Seething Lane, London, E.C.3.—Capital, £40,000. Dealers in ores, metals, minerals, etc.

Basic Furnaces, Limited.—Capital, £1,000. Subscribers: E. Rudland, 2, Bond Court, Walbrook, London, E.C.4; R. Smith.

Coggon Foundry Equipment, Limited, Shay Lane Works, Ovenden, Halifax.—Capital, £20,000. Directors: H. F. Coggon and A. Kitchen.

Stoner & Saunders, Limited, Balfour House, Finsbury Pavement, London, E.C.2. —Capital, £1,000. Founders and cast lead specialists, etc. Directors: J. E. G. Cole and Mrs. D. L. Cole.

Stevensons, Limited, Canal Foundry, Fylde Road, Preston.—Capital, £100. Iron, steel, brass and bronze founders, etc. Directors: J. Sadler, A. Barnes, and H. Blackburn, Junr.

Company Reports

Hick, Hargreaves & Company, Limited.—Interim dividend at the rate of 2 per cent.

Herbert Morris, Limited.—Half-year's dividend to January 31, 1937, on the 5 per cent. cumulative preference shares.

Ductile Steels, Limited.—Interim dividend of 5 per cent. on the 5s. ordinary shares on account of the period ending June 30, 1937.

Contract Open

Buenos Aires.—Four electrically driven horizontal shaft, centrifugal pumping sets, for Argentine National Sanitation Works Department. Department of Overseas Trade. (Reference No. T.Y. 2,294.)

Obituary

MR. GEORGE MOIR, who died in New Westminster, Vancouver, B.C., recently, was formerly foreman moulder with Harpers, Limited, of Craiginches Iron Works.

MR. ARTHUR J. H. POLLEN, chairman of Follsain Metals, Limited, and a director of the Birmingham Small Arms Company and the Daimler Company, has died recently, aged 70.

THE DEATH HAS OCCURRED of Mr. Harry Pemberton, who for over 31 years has been foundry manager of the C.M.E. Department of the Derby Locomotive Works of the London Midland & Scottish Railway Company. Mr. Pemberton joined the Institute of British Foundrymen in 1906 and was originally attached to the Birmingham Branch, of which he became a Vice-President. Later, however, he called a meeting of foundrymen at Derby and created there the East Midlands Branch. Mr. Pemberton was 58 years of age.

Personal

MR. H. A. REINCKE, who has been elected a director and chairman of the Triumph Company, Limited, is a director of William Beardmore, Limited, and was formerly associated with John Brown & Company, of Sheffield.

MR. W. H. HEATON, general manager of the General Electric Company, Limited, Witton, Birmingham, has been elected President of the Birmingham, Wolverhampton and Stafford District Engineering and Allied Employers' Association.

MR. ROBERT GREENHALGH, manager and chairman of Greenhalgh & Company, Limited, engineers and ironfounders, of Atherton, Lancs, has resigned from the Leigh Bench of County Magistrates. Mr. Greenhalgh was appointed a Justice of the Peace in 1897.

DR. HAROLD MOORE, C.B.E., a director of the British Non-Ferrous Metals Research Association, and Mr. W. Murray Morrison, vice-chairman and managing director of the British Aluminium Company, Limited, have been elected Fellows of the Institute of Metals.

THE LORD CHANCELLOR has appointed Mr. John A. Chambers, joint managing director of Gaskell & Chambers, Limited, brassfounders, of Dale End, Birmingham; Mr. Ernest L. Payton, deputy chairman and financial director of the Austin Motor Company, Limited; and Mr. Henry A. Sale, a director of H. B. Sale, Limited, bronze founders, of Summer Lane, Birmingham, as Justices of the Peace for the City of Birmingham.

AMONGST THE New Year's Honours are several conferred upon gentlemen connected with the foundry industry. Lord Greenwood, who is now a viscount, is chairman of Dorman, Long & Company, Limited. Sir Harry McGowan, now a baronet, is chairman of Imperial Chemical Industries, Limited; Mr. N. L. Campbell, now a knight, is a director of Stewarts and Lloyds, Limited; Mr. J. A. Aiton, C.B.E., now a knight, is a director of Aiton & Company, Limited, ironfounders, of Derby; Mr. W. B. Lang, J.P., now a knight, is chairman of the Machine Tool Trades Association; and Mr. H. T. Tizard, Rector of the Imperial College of Science, and frequent speaker at technical institute banquets, now a Knight Commander of the Bath.

Wills

PROSSER, O. A., London representative of Newton, Chambers & Company, Limited, Thorncliffe, Sheffield ... £934

JOICEY, THE RIGHT HON. JAMES, BARON, of Ford Castle, Northumberland, chairman of the Lambton, Hetton & Joicey Collieries, Limited £1,519,717

TENNANT, ROBERT HUGH, deputy chairman of the Stanton Ironworks Company, Limited, director of the Holwell Iron Company, Limited £347,120

Forthcoming Events

FEBRUARY 12.

Keighley Association of Engineers:—"The Manufacture of Steel Castings." Paper by Dr. Dadswell, Ph.D., at the Queen's Hotel, Keighley, at 7.30 p.m.

Institute of British Foundrymen

FEBRUARY 9.

Burnley Section:—"The Making of a Pattern Plate." Paper by R. Swain, at the Municipal College, Ormerod Road, Burnley, at 7.15 p.m.

FEBRUARY 13.

Scottish Branch:—Annual General Meeting. "Gates and Risers," on (*a*) Grey Iron Castings, (*b*) Steel Castings, two Papers by J. Longden and A. D. Kirby respectively, at the Royal Technical College, Glasgow, at 4 p.m.

Wales and Monmouth Branch:—Joint meeting with the South Wales Institute of Engineers. Discussion on Sub-Committee's Report "Dimensional Tolerances for Castings, with Particular Reference to Malleable Cast Iron," at the University College, Newport Road, Cardiff, at 6.30 p.m.

West Riding of Yorkshire Branch:—"Modern Methods in the Core Shop." Paper by W. H. Smith, at the Technical College, Bradford, at 6.30 p.m.

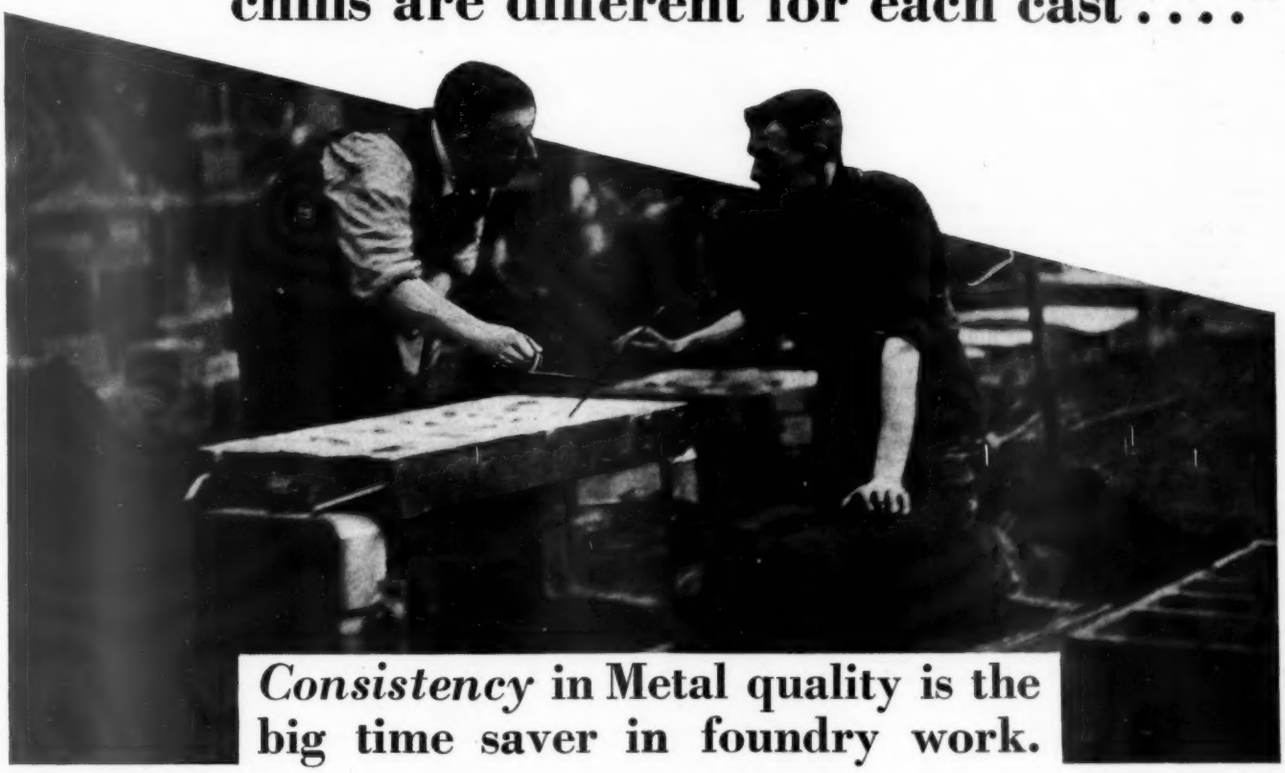
The Institute of Vitreous Enamellers

FEBRUARY 11.

Southern Section:—"A *Résumé* of Some Studies on Sheet Steel Ground Coat Enamels," Paper by Prof. R. M. King, of Chicago, to be read by A. Edwards, at the British Industries House, Marble Arch, London, W.1, at 8 p.m.

"And I tell YOU . . .

that you can't finish a mould quickly when they give us remelt . . . the gates and risers and chills are different for each cast . . . ."



Consistency **in Metal quality is the big time saver in foundry work.**

Consistency is ensured **by the use of virgin aluminium and alloys, as supplied by**

THE British Aluminium CO. LTD

HEAD OFFICE: ADELAIDE HOUSE, LONDON, E.C.4

Telephone: Mansion House 5561 & 8074 (6 lines) *Telegrams: Cryolite, Bilgate, London*

F.T.J. 4·2·37

Raw Material Markets

Activity in the iron and steel industry is practically confined to the execution of deliveries under existing contracts. Producers are unable to accept new inquiries. Prospects of any material increase in output are small.

Pig-Iron

MIDDLESBROUGH.—Inquiries for supplies of pig-iron have been very heavy for a long time past on both home and export account, but, conditions being what they are, only a very few new orders can be accepted. Producers are hard pressed to meet contract commitments which were arranged months ago. The fixed minimum prices are 81s. per ton for No. 3 Cleveland G.M.B. delivered in the Middlesbrough district, 83s. elsewhere on the North-East Coast, 84s. in Falkirk, and 87s. in Glasgow.

Contract deliveries also absorb the full output of hematite and supplies on the open market are negligible. Deliveries are well maintained, but until a substantial increase is made in production no new orders can be entertained. East Coast mixed numbers are quoted on the North-East Coast at 97s. 6d. per ton, less 5s. rebate.

LANCASHIRE.—Pig-iron consumption is at a high rate in this area, and deliveries against contracts are heavy. New business, however, remains only small. For delivery to users in the Lancashire price zone, offers of Derbyshire and Staffordshire qualities of No. 3 foundry iron are on the basis of 89s. per ton, with Northamptonshire at 87s. 6d. and Derbyshire forge iron at from 84s. to 86s. per ton. Consumers of hematite have satisfactory requirements. Prices are firm, with West Coast iron at 106s. per ton, delivered equal to Manchester, and East Coast hematite at 105s. 6d. Scottish foundry iron is quoted in the region of 105s. per ton.

MIDLANDS.—There is a heavy inquiry for pig-iron from the engineering and light-castings branches of the industry, but, while deliveries have been kept up to schedule, there remains little surplus material for disposal on the open market. As it is, users have had to accept grades other than those ordered in many cases. It is easier to obtain Derbyshire iron than Northamptonshire material, the output of which is immediately taken up. The Association minimum quotations are 83s. 6d. for Northants No. 3 and 86s. for Derbyshire and Lincolnshire No. 3, delivered to Birmingham and Black Country stations. Many complaints are received to the effect that deliveries of hematite are behind schedule. This applies more particularly to the special qualities. Renewals of contracts are being made, but new business is of little consequence. West Coast mixed numbers are quoted at £5 9s. 6d., East Coast No. 3 at £5 8s. 6d., and Welsh mixed numbers at £5 8s. An extra of 1s. 6d. per ton is charged where delivery into Midland works is stipulated.

SCOTLAND.—Firm conditions continue to prevail in this area. Makers are despatching all the iron possible, but users have considerable requirements which cannot be met under existing conditions. No. 1 foundry is quoted at 90s. 6d. and No. 3 foundry at 88s., f.o.t. furnaces. Cleveland iron is quoted at 84s. f.o.t. Falkirk and 87s. f.o.t. Glasgow for No. 3 foundry, with Staffordshire No. 3 at 1s. 3d. per ton less than the foregoing figures. Local steelworks are fully active, but they are unable to procure all their requirements of pig-iron. Hematite mixed numbers are quoted at 98s., less 5s. rebate, and basic, British and Indian, is 82s. 6d., less 5s. rebate, both delivered steelworks here.

Coke

Any new business that is transacted in the foundry-coke market is frequently at prices above those that have been ruling in recent weeks. Most consumers are well covered, however, and their main concern is to obtain adequate deliveries, which, in many cases, have fallen behind schedule. For delivery in Birmingham and district, best Durham coke is quoted at from 42s. 6d. to 45s., and Welsh from 40s. up to 54s. per ton.

Steel

The demand for all descriptions of steel is well in excess of the production, and the British works are given little opportunity of overtaking arrears in deliveries, says the official report of the London Iron and Steel Exchange. With these conditions ruling in the home market, little material is left for export, although efforts are being made to retain old connections in the Dominions and foreign countries. Consumers' requirements of semi-finished steel are in excess of the British production, and some users are nervous regarding their future supplies, particularly as there seems little prospect of arranging for an adequate increase in the quantities imported. The home market easily absorbs the present output, and, although production may be expanded shortly, it is doubtful if the additional tonnage will be sufficient to satisfy consumers' requirements. Similar conditions rule in the finished-steel market. All the heavy steelmakers are booked up for months to come upon home contracts, and are exercising caution in undertaking fresh commitments. A certain amount of export business is accepted, but it is only with difficulty that a part of the large volume of oversea inquiry can be satisfied.

Scrap

The Import Duties Advisory Committee is understood to have received an application for an embargo prohibiting the export of iron and steel scrap materials. This move has been brought about by the increasing alarm regarding the prospects of a serious shortage of scrap, but the success of the application remains to be seen, as the difficulties to be overcome are considerable. Imports of scrap have declined considerably.

Prices in the Cleveland area are generally unchanged and firm. Only comparatively small tonnages can be obtained at current figures. There is a heavy demand in South Wales, but the lack of material is restricting trade. Prices display a rising tendency in Birmingham, but they have become rather more stable of late. Small parcels for prompt delivery are changing hands, but few large transactions are reported. Similar conditions prevail throughout the Midlands. While 60s. is still accepted in some cases for supplies of heavy steel in furnace sizes, slightly more is frequently obtained. Other materials also show higher prices. Producers in Yorkshire, also, are demanding higher figures, while business in Lancashire is being done at figures over and above those generally quoted. The shortage of scrap is severe in Scotland, where there is a heavy inquiry. Prices are unchanged as yet, but advances are expected in the near future.

Metals

Copper.—There has been a moderate trade demand during the past week, and consumption has been well maintained. The market is rather uncertain at present, and new buying is not likely to assume substantial proportions until the outlook becomes more settled. Industrial operations in the United States, which have been disturbed recently by the prevalence of extensive labour disputes, have been further restricted by the disastrous floods.

The trend of the copper industry during 1936 is revealed in preliminary figures issued by the United States Bureau of Mines. The smelter output of copper from domestic ores at 613,000 short tons was 61 per cent. higher than in the previous year, while at the same figure refinery production was 81 per cent. higher than in 1935. Refinery output from foreign ores, however, showed a decrease of 22 per cent., thus reducing the increase in the total refined primary output to 37 per cent. The apparent consumption of refined primary metal increased 46 per cent., and was the highest recorded since 1929. The Bureau of Mines states that the copper price moved upwards rather conservatively as a result of record-breaking sales on several occasions, but the price spurted 1¼ cents per lb. in December, when speculative interest was added to increased consumptive demand.

Daily market prices :—

Cash.—Thursday, £51 17s. 6d. to £51 18s. 9d.; Friday, £52 2s. 6d. to £52 3s. 9d.; Monday, £52 15s. to £52 16s. 3d.; Tuesday, £53 3s. 9d. to £53 6s. 3d.; Wednesday, £54 5s. to £54 6s. 3d.

Three Months.—Thursday, £52 to £52 1s. 3d.; Friday, £52 5s. to £52 6s. 3d.; Monday, £52 18s. 9d. to £53; Tuesday, £53 7s. 6d. to £53 8s. 9d.; Wednesday, £54 6s. 3d. to £54 7s. 6d.

Tin.—This market has remained rather featureless, and business has been quiet. According to the statistics prepared by Mr. W. H. Gartsen (Henry Rogers, Sons & Company) the total visible supplies of tin at the end of January were 19,791 tons, which is only 69 tons higher than at the end of December. The carry-over in the Straits Settlements rose by 1,446 tons to 3,568 tons, while the carry-over at the Arnhem (Holland) smelter was 1,563 tons, against 851 tons a month ago. Thus, the total supplies in sight at the end of January at 24,922 tons were 2,227 tons higher than at the end of December. In the United States, strike troubles continue to influence operations at the consuming plants, and thus consumption at the present time is at an artificial level.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £225 7s. 6d. to £225 12s. 6d.; Friday, £225 to £225 5s.; Monday, £225 10s. to £225 15s.; Tuesday, £227 to £227 5s.; Wednesday, £228 15s. to £229.

Three Months.—Thursday, £226 to £226 5s.; Friday, £225 10s. to £225 15s.; Monday, £226 5s. to £226 10s.; Tuesday, £227 15s. to £228; Wednesday, £229 10s. to £229 15s.

Spelter.—Although there is a steadily increasing demand for this metal, production is also advancing and is still in excess of current requirements. It is reported that producers in France and Belgium have recently re-opened their works, and that a considerable tonnage of Belgian metal is going into warehouse. Activity at the galvanising works in the United States has risen to around 74 per cent. of capacity, but, apart from this source of consumption, the market is in a dull state.

Official quotations were as follow :—

Ordinary.—Thursday, £21 13s. 9d.; Friday, £21 6s. 3d.; Monday, £21 2s. 6d.; Tuesday, £21 2s. 6d.; Wednesday, £21 16s. 3d.

Lead.—Consumers generally have continued their policy of holding aloof from the market, and quiet conditions have ruled. Industrial demand in the United States has been satisfactory in spite of strikes, and the outlook is sound. There is a good inquiry for small tonnages for early delivery, but most users are well covered and do not show much interest in forward contracts.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £26 13s. 9d.; Friday, £26 6s. 3d.; Monday, £26 6s. 3d.; Tuesday, £26 8s. 9d.; Wednesday, £27 7s. 6d.

Platinum Prices.—Platinum is now officially quoted at £14 per fine ounce. The price was raised £2 last week and has since been advanced by £2 15s. The quotation is now double that which ruled at this time last year. The latest price movement follows an increase of $10 to $68 an ounce in New York.

Moulding Machines.—R. J. Richardson & Sons, Limited, of Commercial Street, Birmingham, 1, have used a blotter to draw attention to two types of hand press moulding machines which they manufacture. Style A, made in two sizes, takes boxes up to 36 in. by 14 in., and style R.J.R. is smaller and operates with boxes up to 18 in. by 15 in. Balanced hand lever action is used in both cases.

WHEN THINKING OF
SANDBLAST
THINK OF
RICHARDSON'S
Established 1887.
We Supply Re-Conditioned & New
SAND BLAST PLANTS
AND
AIR COMPRESSORS.
Tilghman's, Room, Barrel, Chamber, Rotary Table, Dust Arrester, and Continuous Feed Barrel Plants.
Phone: MIDLAND 2281.
Grams: "SANDBLAST, B'HAM."
R. J. RICHARDSON & SONS, Ltd.,
Commercial Street, Birmingham.

We cordially invite you to

PAY A VISIT TO OUR STAND

at the

A few of the PRODUCTS to be EXHIBITED :—

SAXPYRE
DIAZITE
SUPERMAG
INSULITE
SINTEX
DURAX
and
SANDS
of all types

There will be SPECIAL DISPLAYS of:—

BASIC REFRACTORIES

INSULATING MATERIALS

FIREBRICKS

PLASTIC REFRACTORIES

GENERAL REFRACTORIES
LIMITED

Telephone : 31113 (6 lines)

Genefax House, Sheffield, 10

Telegrams : "Genefax, Sheffield"

Manufacturers of Heat Resisting and Heat Insulating Materials of every description.

WORKS, OFFICES, MINES AND QUARRIES THROUGHOUT THE WORLD,

STAND Nos. D.913 & 810

RAW MATERIALS—PRICE LIST

(Wednesday, February 3, 1937)

COPPER

	£ s. d.
Standard cash	54 5 0
Three months	54 6 3
Electrolytic	58 15 0
Tough	58 6 3
Best selected	58 16 3
Sheets	86 1 3
India	69 6 3
Wire bars	60 1 3
Ingot bars	59 16 3
H.C. wire rods	62 17 6
Off. av. cash, Jan.	51 10 10½
Do., 3 mths., Jan.	51 13 4⅞
Do., Sttlmnt., Jan.	51 10 6
Do., Electro, Jan.	56 13 0⅜
Do., B.S., Jan.	56 3 9
Do., wire bars, Jan.	57 0 4½
Solid drawn tubes	12¾d.
Brazed tubes	12¾d.
Wire	8d.

BRASS

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10d.
Rods, extd. or rlld.	6d.
Sheets to 10 w.g.	9½d.
Wire	9½d.
Rolled metal	8¾d.
Yellow metal rods	6d.

TIN

	£ s. d.
Standard cash	228 15 0
Three months	229 10 0
English	228 15 0
Bars	231 0 0
Straits	231 5 0
Australian	228 15 0
Eastern	229 17 6
Banca	230 15 0
Off. av. cash, Jan.	229 9 10½
Do., 3 mths., Jan.	230 4 1½
Do., Sttlmt., Jan.	229 10 0

SPELTER

	£ s. d.
Ordinary	21 16 3
Remelted	20 0 0
Hard	19 5 0
Electro 99.9	23 17 6
English	22 15 0
India	18 5 0
Zinc dust	25 10 0
Zinc ashes	6 0 0
Off. aver., Jan.	21 4 4½
Aver. spot, Jan.	21 3 0¾

LEAD

	£ s. d.
Soft foreign ppt.	27 7 6
Empire	27 3 9
English	29 5 0
Off. aver., Jan.	27 4 2⅝
Aver. spot, Jan.	27 5 5½

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English 33	5 0 to 33 15 0
Do., V.M. ex-whse. 33	5 0 to 33 15 0
Rods	31 10 0

ANTIMONY

	£ s. d.
English	77 0 0 to 78 0 0
Chinese, ex-whse.	64 0 0
Crude, c.i.f.	35 0 0

QUICKSILVER

	£ s. d.
Quicksilver	14 2 6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£ 2 6
45/50%	10 15 0 to 12 0 0
75%	15 15 0 to 17 0 0
Ferro-vanadium—	
35/50%	12/8 lb. Va
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/1½ lb.
Ferro-chrome—	
2/4% car.	31 17 6
4/6% car.	21 10 0
6/8% car.	21 0 0
8/10% car.	21 0 0
Ferro-chrome—	
Max. 2% car.	32 10 0
Max. 1% car.	35 15 0
Max. 0.5% car.	36 10 0
70% carbon-free	9½d. lb.
Nickel—99.5/100%	£180 to £185
"F" nickel shot	£165 0 0
Ferro-cobalt, 98/99%	7/3 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese—	
76/80% loose	£11 15 0 to 12 5 0
76/80% packed	£12 15 0 to 13 5 0
76/80% export	£10 15 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{5}{16}$ in.	1/- lb.
Flats, ½ in. × ⅛ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ⅛ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

South Wales—	£ s. d.	£ s. d.
Heavy steel		3 10 0
Mixed iron and steel	3 7 6	to 3 8 0
Heavy cast iron	3 6 0	to 3 7 6
Good machinery		4 0 0
Cleveland—		
Heavy steel		3 2 6
Steel turnings		2 5 0
Heavy cast iron		3 10 0
Heavy machinery		3 15 0
Midlands—		
Short heavy steel		3 10 0
Light cast-iron scrap	2 15 0	to 2 17 6
Heavy wrought iron		3 10 0
Steel turnings		2 2 6
Scotland—		
Heavy steel		3 2 6
Ordinary cast iron	3 8 6	to 3 10 0
Engineers' turnings		2 7 6
Cast-iron borings		2 2 6
Wrot-iron piling	3 12 6	to 3 15 0
Heavy machinery	3 15 0	to 4 0 0

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	42 0 0
Brass	24 10 0
Lead (less usual draft)	22 10 0
Tea lead	17 10 0
Zinc	12 10 0
New aluminium cuttings	74 0 0
Braziery copper	40 0 0
Gunmetal	41 0 0
Hollow pewter	170 0 0
Shaped black pewter	124 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	83/6
,, No. 3	81/-
,, No. 4	80/-
Forge No. 4	80/-
Hematite No. 1	98/-*
Hematite M/Nos.	97/6*
N.W. Coast—	
Hem. M/Nos. d/d Glas.	98/-*
,, d/d Birm.	109/6*
Malleable iron d/d Birm.	—
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	83/-
,, No. 3 fdry.	86/-
Northants forge	80/6
,, fdry. No. 3	83/6
,, fdry. No. 1	86/6
Derbyshire forge	83/-
,, fdry. No. 3	86/-
,, fdry. No. 1	89/-
Scotland—	
Foundry, No. 1, f.o.t.	90/6
,, No. 3, f.o.t.	88/-
Cleveland No. 3, Glasgow	87/-
,, ,, Falkirk	84/-
Scottish hem. M/Nos. d/d	98/-*
Sheffield (d/d district)—	
Derby forge	80/6
,, fdry. No. 3	83/6
Lincs forge	80/6
,, fdry. No. 3	83/6
W.C. hematite	103/6*
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	89/-
Staffs fdry. No. 3	89/-
Northants fdry. No. 3	87/6
Cleveland fdry. No. 3	89/-
Glengarnock, No. 3	105/-
Clyde, No. 3	105/-
Monkland, No. 3	105/-
Summerlee, No. 3	105/-
Eglinton, No. 3	105/-
Gartsherrie, No. 3	105/-
Shotts, No. 3	105/-

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)		10 10 0
Nut and bolt iron	8 17 6	to 9 7 6
Hoops	11 7 6	and up.
Marked bars (Staffs) f.o.t.		13 0 0
Gas strip	11 7 6	and up.
Bolts and nuts, ¾ in. × 4 in.		16 0 0 and up.
Steel—		
Plates, ship, etc.	9 10 6	to 9 13 0
Boiler plts	10 0 6	to 10 3 0
Chequer plts.		11 3 0
Angles		9 3 0
Tees		10 3 0
Joists		9 3 0
Rounds and squares, 3 in. to 5½ in.		10 3 0
Rounds under 3 in. to ⅜ in. (Untested)		9 10 0
Flats—8 in. wide and over		9 8 0
,, under 8 in. and over 5 in.		9 13 0
Rails, heavy	8 5 0	to 8 10 0
Fishplates		12 10 0
Hoops (Staffs)		10 5 0
Black sheets, 24g. (4-t. lots)		12 0 0
Galv. cor. shts. (,,)		14 0 0
Galv. flat shts. (,,)		14 10 0
Galv. fencing wire, 8g. plain		15 10 0
Billets, soft		6 5 0
Sheet bars	6 2 6	to 6 10 0
Tin bars	6 2 6	to 6 10 0

PHOSPHOR BRONZE

	Per lb. basis
Strip	12½d.
Sheet to 10 w.g.	13½d.
Wire	14½d.
Rods	14d.
Tubes	16½d.
Castings	14d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	8d. to 1/2
Rolled—	
To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2½ to 1/8½
To 15 in. wide	1/2½ to 1/8½
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	8d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round—	
to 10g.	1/5½ to 2/0½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/4½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	22.76
No. 2 foundry, Valley	21.00
No. 2 foundry, Birm.	17.38
Basic, Valley	20.50
Malleable, Valley	21.00
Grey forge, Valley	20.50
Ferro-mang. 80%, seaboard	80.00
O.-h. rails, h'y, at mill	39.00
Billets	34.00
Sheet bars	34.00
Wire rods	43.00
	Cents.
Iron bars, Chicago	2.15
Steel bars	2.20
Tank plates	2.05
Beams, etc.	1.90
Skelp, grooved steel	1.80
Steel hoops	1.95
Sheets, black, No. 24	2.80
Sheets, galv., No. 24	3.40
Wire nails	2.25
Plain wire	2.60
Barbed wire, galv.	2.75
Tinplates, 100-lb box	$4.85

COKE (at ovens)

Welsh foundry	30/- to 32/6
,, furnace	24/6 to 25/-
Durham foundry	24/3 to 25/-
,, furnace	21/3 to 22/-
Scotland, foundry	28/-
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	19/9 to 20/3
,,	28×20 ,,	39/6 to 40/-
,,	20×10 ,,	28/- to 28/3
,,	18¾×14 ,,	20/6 to 21/-
C.W.	20×14 ,,	17/- to 17/3
,,	28×20 ,,	35/6 to 35/9
,,	20×10 ,,	23/9 to 24/-
,,	18¾×14 ,,	17/3 to 17/6

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£8 0 0 to £9 0 0
Bars-hammered, basis	£16 0 0 to £16 10 0
Bars and nail-rods, rolled, basis	£15 15 0 to £16 0 0
Blooms	£12 0 0 to £14 0 0
Keg steel	£26 0 0 to £29 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£11 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

			£	s.	d.	
Jan.	28	..	51	17	6	dec. 11/3
,,	29	..	52	2	6	inc. 5/-
Feb.	1	..	52	15	0	,, 12/6
,,	2	..	53	3	9	,, 8/9
,,	3	..	54	5	0	,, 21/3

Electrolytic Copper

			£	s.	d.	
Jan.	28	..	56	15	0	dec. 5/-
,,	29	..	56	15	0	No change
Feb.	1	..	57	15	0	inc. 20/-
,,	2	..	58	0	0	,, 5/-
,,	3	..	58	15	0	,, 15/-

Standard Tin (cash)

			£	s.	d.	
Jan.	28	..	225	7	6	dec. 32/6
,,	29	..	225	0	0	,, 7/6
Feb.	1	..	225	10	0	inc. 10/-
,,	2	..	227	0	0	,, 30/-
,,	3	..	228	15	0	,, 35/-

Tin (English ingots)

			£	s.	d.	
Jan.	28	..	225	10	0	dec. 35/-
,,	29	..	225	5	0	,, 5/-
Feb.	1	..	225	10	0	inc. 5/-
,,	2	..	227	5	0	,, 35/-
,,	3	..	228	15	0	,, 30/-

Spelter (ordinary)

			£	s.	d.	
Jan.	28	..	21	13	9	dec. 2/6
,,	29	..	21	6	3	,, 7/6
Feb.	1	..	21	2	6	,, 3/9
,,	2	..	21	2	6	No change
,,	3	..	21	16	3	inc. 13/9

Spelter (Electro, 99.9 per cent.)

			£	s.	d.	
Jan.	28	..	23	10	0	dec. 2/6
,,	29	..	23	3	9	,, 6/3
Feb.	1	..	23	3	9	No change
,,	2	..	23	3	9	,, ,,
,,	3	..	23	17	6	inc. 13/9

Lead (soft foreign, prompt)

			£	s.	d.	
Jan.	28	..	26	13	9	dec. 11/3
,,	29	..	26	6	3	,, 7/6
Feb.	1	..	26	6	3	No change
,,	2	..	26	8	9	inc. 2/6
,,	3	..	27	7	6	,, 18/9

Lead (English)

			£	s.	d.	
Jan.	28	..	28	15	0	dec. 10/-
,,	29	..	28	5	0	,, 10/-
Feb.	1	..	28	5	0	No change
,,	2	..	28	10	0	inc. 5/-
,,	3	..	29	5	0	,, 15/-

AVERAGE MONTHLY PRICES OF STEEL BOILER PLATES IN ENGLAND

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1900	9 5 0	9 5 0	9 7 6	9 10 0	9 12 6	10 5 0	10 5 0	10 5 0	10 5 0	10 0 0	9 15 0	9 15 0	9 15 10
1901	9 5 0	9 5 0	8 15 0	8 10 0	8 10 0	7 10 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 3 11
1902	7 7 6	7 0 0	7 12 6	7 12 6	7 12 6	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 9 7
1903	7 10 0	7 10 0	7 15 0	7 5 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 3 11½
1904	6 12 6	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 11½
1905	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 10 0	7 0 0	8 0 0	8 0 0	7 1 3
1906	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 0 10
1907	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 8 4
1908	7 10 0	7 10 0	7 10 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 3 9
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 9
1910	7 0 0	7 0 0	7 1 3	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 10 0	7 10 0	7 10 0	7 5 1
1911	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 14 0	7 10 4
1912	7 18 9	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 15 0	8 16 3	9 0 0	9 2 0	9 5 0	8 11 2½
1913	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	8 19 0	8 15 0	8 5 0	7 15 0	7 15 0	8 17 0
1914	7 15 0	7 15 0	7 15 0	7 13 9	7 10 6	7 5 0	7 0 0	8 0 0	8 2 6	8 5 0	8 5 0	8 5 0	7 15 11½
1915	8 14 0	9 10 0	9 17 6	10 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 4 0	12 0 0	13 0 0	10 15 5½
1916	13 0 0	13 0 0	13 0 0	12 15 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 12 11
1917	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1918	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1919	13 0 0	15 0 0	15 0 0	15 0 0	19 5 0	19 17 6	21 0 0	21 10 0	21 10 0	21 10 0	21 15 0	23 10 0	18 9 9
1920	28 0 0	28 0 0	28 5 0	28 10 0	29 5 0	30 0 0	30 0 0	30 0 0	30 10 0	31 0 0	31 0 0	31 0 0	29 9 2
1921	30 5 0	29 0 0	25 0 0	25 0 0	25 0 0	23 0 0	21 0 0	20 10 0	19 0 0	17 10 0	16 0 0	14 16 0	22 1 9
1922	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 1 8	13 10 0	12 15 0	12 10 0	12 10 0	12 10 0	12 6 0	13 10 9
1923	12 8 9	13 6 0	14 0 0	14 0 0	14 0 0	14 0 0	13 12 6	13 0 0	13 0 0	13 0 0	13 0 0	13 10 0	13 9 1½
1924	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	14 0 0	14 0 0	13 11 0	13 5 0	13 5 0	13 10 11
1925	13 5 0	13 5 0	13 5 0	13 1 0	12 15 0	12 15 0	12 15 0	12 15 0	12 7 6	11 14 0	11 10 0	11 10 0	12 11 5½
1926	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 6 3
1927	11 5 0	11 5 0	11 5 0	11 5 0	11 2 6	11 0 0	11 0 0	11 0 0	10 16 0	10 10 9	10 10 0	10 10 0	10 19 0½
1928	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1929	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 5 0	10 1 3	10 1 3	10 1 3	10 1 7	10 6 8½
1930	10 2 9	10 3 5½	10 3 9	10 3 9	10 3 6	10 2 6	10 2 6	10 2 6	10 2 2½	9 19 6	9 16 3	9 16 3	10 1 6½
1931	9 15 0	9 15 0	9 15 0	9 10 11	9 6 9	9 5 0	9 7 0	9 7 9½	9 8 9	9 5 6	9 5 6	9 9 6	9 9 4
1932	9 5 0	9 2 6	8 18 6	8 17 6	8 16 6½	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 17 10
1933	8 10 0	8 10 0	8 10 0	8 8 9	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 6 0	8 7 6	8 6 10½
1934	8 8 1½	8 10 7½	8 16 6	8 17 6	8 6 3	8 6 3	8 5 7½	8 5 0	8 5 0	8 5 0	9 6 3	9 6 3	8 11 8½
1935	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3
1936	9 6 3	9 6 3	9 6 3	9 6 3	9 9 4½	9 18 9	9 18 9	9 18 9	9 18 9	9 18 9	9 18 9	9 19 4	9 13 10½
1937	10 1 9	—	—	—	—	—	—	—	—	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

LUMPEX

FOR EVERY TYPE OF CASTING

NON-FERROUS METALS

REFRACTORIES — COKE — SAND

FERRO-SILICON—FERRO-CHROME

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

Notice

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

CHEMIST and Metallurgist with City and Guilds final certificate in iron and steel manufacture, metallography, Inorganic chemistry, desires change. Fifteen years' practical experience of basic open-hearth, tropenas, converters and cupolas in modern steelfoundry.—Box 220, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

CONSULTANT on foundry work, comprising iron, steel, non-ferrous alloys, including aluminium and light alloys, acts independently. Unbiased reports given, based on 25 years' experience. Also arrange reports for company reorganisation. In strictest confidence write: Box 194, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

CUPOLA Man, experienced, desires change. Used to cupolas melting 4 to 8 tons per hr.; also used to balanced blast cupolas.—Box 214, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRYMAN, 30 years' experience all types of moulding machines and methods; practical knowledge of modern requirements, general layouts and handling equipment; desires post on sales or design. Could introduce three lines with good potential market.—Box 184, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MECHANICAL ENGINEER SEEKS POSITION IN MECHANISED FOUNDRY. Capable designer-draughtsman; accustomed to plant maintenance and reconstruction, including modern power plant. Experienced in heavy machine-shop practice. Age 31.—Box 218, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PRACTICAL and Technical Foundry Engineer desires position abroad or home. Speaks Spanish and Portuguese. Can start foundry, layout moulding machines (air, hydraulic or electric). Plan moulding plates. Jobbing work. Used to all kinds of smelting furnaces. Any metal or alloy. Honours iron and steel metallurgy. Handle any labour, male and female. Just completed contract, Brazil, S.A. None but firms of good standing or financiers desirable. Interviews out of London, expenses to be paid.—Box 216, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

DESIGNER.—A firm of ironfounders is desirous of securing modern designs for Coal-fired Ranges, Mantel Registers and other classes of Domestic Light Castings. Anyone desiring to compete should send particulars of qualifications and terms.—Address "DESIGNER," WM. PORTEOUS & CO., Glasgow.

WANTED.—Working Foundry Foreman for non-ferrous castings. State age, experience, and salary required.—Box 208, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY

WANTED.—One or two "Denbigh" hand-operated Roll-over Jolt-ram Moulding Machines, suitable for making oil axleboxes for 12-ton railway wagons.—Box 210, Offices of THE FOUNDRY TRADE JOURNAL, 49, Welllington Street, Strand, London, W.C.2.

WANTED.—Second-hand Rotoil Mixing Machine in good condition. State keenest price.—Box 212, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY—*Continued*

TWO Britannia Jolt-Ram Machines, ramming capacity 10 cwts. at 80 lbs. air pressure; pattern draws 8" and 15"; thoroughly overhauled and in first-class condition. Price £30 each.—WARDLE, Wilton House, Mellor, near Stockport.

TWO 200-lb. "Forster" Oil-fired Melting Furnaces by British Furnaces, Ltd., Chesterfield. Open to receive offers from interested purchasers after inspection by appointment.—D. NAPIER & SON, LTD., Acton, London, W.3.

PRACTICALLY new Sand Blast Room Plant by Tilghman, with steel room 12 ft. by 9 ft. by 8 ft. 6 in. high, complete with Tilghman compressor, 300 cub. ft. capacity, necessary air receiver, pipework and sandblast apparatus, exhausting fan, etc. This plant is not now required owing to the closing of a foundry. Can be seen in the Manchester district, as erected. Cheap price before removal. This plant is for all practical purposes as new.—Box 198, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

HYDRAULIC MACHINE MOULDING PLANT AND MOULD CONVEYOR.

TWO Roll-over Moulding Machines to take boxes up to 32 in. by 22 in. by 14 in., complete with downsand frames.

Two Swing-head Moulding Machines to take boxes up to 37 in. by 24 in. by 8 in.

Hydraulic Pump, Accumulator and Copper Piping to operate the above machines.

One Platform-type Return Track Mould Conveyor, 145 ft. 3½ in. by 5 ft. 9½ in. track centres, with 66 platforms each 3 ft. 3 in. by 2 ft. 3 in. at 4 ft. 6 in. pitch. 15-h.p. Motor, 415 volts, 50 cycles, 3-phase, and reduction gear giving speeds of 6.75 f.p.m., and 4 f.p.m. Can be adapted to give 9 f.p.m.

Apply:—

MESSRS. BELLING & CO., LTD.,
BRIDGE WORKS, SOUTHBURY ROAD, ENFIELD.

Tilghman Sandblast Barrel Plants; barrel sizes—60 in. x 40 in.; 36 in. x 20 in.; 20 in. x 30 in.

Tilghman Sandblast Cabinet Plants; 4 ft. 6 in. and 3 ft. 6 in. square (one for high pressure 70 lbs. per sq. in.); also small Cabinet 30 in. dia.

All complete with Air Compressors, etc.

Gas and Air Mixer by Sharpe & Preston, 2-in. outlet.

Six Osborne Pneumatic Jolt Press Moulding Machines, size 75J.

Three Mumford Yoke Headpress Pneumatic Moulding Machines.

Two Herbert Whizzer Sand Disintegrators.

Two Brealey Type ditto.

Heavy Double-ended Grinding Machines by Rowlands, Luke & Spencer, etc.

Hand Moulding Machines by Adaptable Darling & Sellars, Pridmore, Samuelson, etc.

500 Electric Motors, Dynamos, Rotary Converters, etc.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.

CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.

'Phone: Broadwell 1359.

THOS. W. WARD LTD.

Macdonald size type T.O. Jolt Turn-over and Pattern Draw MOULDING MACHINE; Mumford plain type Jolter by Jackman; 5′ square table; lifting capacity approx. 5,000 lbs.

VERT. COCHRAN BOILER; 8′ 6″ x 3′ 9″; 100 lbs. w.p.

Second-hand "Lister" PETROL TRUCK; overhauled and in good working order.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued*

'Phone **98** Staines.

ROBEY Vertical Air Compressor, 850 c.f. at 30 lbs.

Air Receiver, 20 ft. by 3 ft., 100 lbs.

Cochran Boiler, 10 ft. 3 in. by 4 ft. 9 in., 100 lbs.

HARRY H. GARDAM & CO., LTD.,
STAINES.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & CO., LTD., Station Works, Ecclesfield, Sheffield.

MISCELLANEOUS

CAST-IRON Scrap, 30 tons per week, required by Bilston ironfoundry consistently. State prices for prompt cash. Please reply to Box 206, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

OUR CORE GUM and "Binderite" Sand-binder acknowledged to be the best obtainable. Write for samples and carriage paid terms.—WILLIAM OLSEN, LTD., Hull.

'Phone: 287 SLOUGH

SEVERAL Good Foundry Grinders, Price, £5 to £20.

12′ square Sand Blast Room Plant complete and in good condition. Price, £180.

Four Morgan Oil-fired Tilting Furnaces reconditioned — 450-lbs. capacity. Also 250-lbs. and 600-lbs. capacity in stock. CHEAP.

Large stock of Moulding Machines, Compressors and A.C. Motors.

PLEASE SEND US YOUR ENQUIRIES.

ALEX. HAMMOND, *Foundry Machinery Merchant.*
14, AUSTRALIA ROAD, SLOUGH
BUY FROM ME AND SAVE MONEY!

SELECT YOUR MACHINE FROM THE LARGEST STOCK OF HIGH-CLASS SECONDHAND MOULDING MACHINES IN THE WORLD

Practical Advice Free

C. W. COLEMAN,
156, STRAND, LONDON, W.C.2.